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PERIPHERAL DEVICE OF COMPUTER FOR AUTOMATICALLY RECOGNIZING STRESS AND SYSTEM FOR DETERMINING STRESS USING THE SAME ;

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ABSTRACT:

The present invention relates to a peripheral device of computer for automatically recognizing stress and system for determining the stress using the device. The system pertaining to the present invention measures and processes body information, such as pulses, skin temperature, skin conductivity and/or muscle conductivity of a computer user by measuring means (500, 600, 700) and process means (400) in a peripheral device (300), produces a stress index from the processed information by a stress-recognizing program in a computer (200), and displays the produced stress index on a display. According to the present invention, the stress index of the user are automatically measured and then displayed, and the user is, therefore, able to take an action for relaxing or lapsing the stress during a working.

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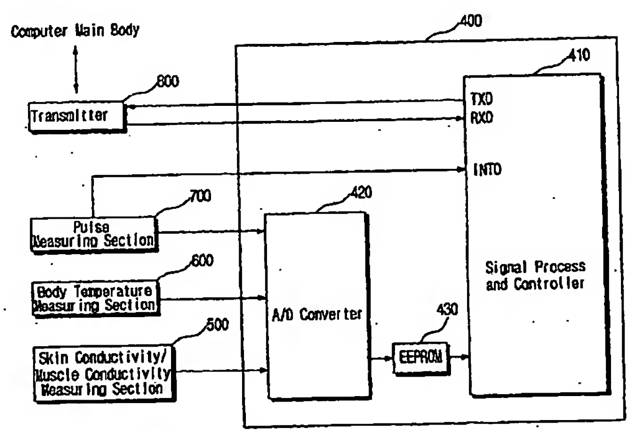
(54) Title: PERIPHERAL DEVICE OF COMPUTER FOR AUTOMATICALLY RECOGNIZING STRESS AND SYSTEM FOR DETERMINING STRESS USING THE SAME.



(57) Abstract: The present invention relates to a peripheral device of computer for automatically recognizing stress and system for determining the stress using the device. The system pertaining to the present invention measures and processes body information, such as pulses, skin temperature, skin conductivity and/or muscle conductivity of a computer user by measuring means (500, 600, 700) and process means (400) in a peripheral device (300), produces a stress index from the processed information by a stress-recognizing program in a computer (200), and displays the produced stress index on a display. According to the present invention, the stress index of the user are automatically measured and then displayed, and the user is, therefore, able to take an action for relaxing or lapsing the stress during a working.

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PERIPHERAL DEVICE OF COMPUTER FOR AUTOMATICALLY RECOGNIZING STRESS AND SYSTEM FOR DETERMINING STRESS USING THE SAME

【Background of the Invention】

This invention relates to a peripheral device of a computer for automatically recognizing stress of the computer user and a stress determining system, and in particular to a peripheral device for automatically recognizing stress and a stress determining system which determines the pulsation, temperature, skin conduction rate and/or muscle conduction rate of the user through a computer peripheral device such as a mouse, and inputs this information into the computer and determines information on respective measurements along with determining the amount of stress and then displaying this information on the monitor.

Recently, as the number of computer users is suddenly increasing, the time of computer usage is increasing in great proportions, and because of this sudden increase in usage time, the stress or VDT syndrome that may be incurred from the computer is becoming a serious problem.

In addition, the people living in the modern day suffer from inevitable stress. This stress is causing much illness and suffering to mankind, and it is safe to presume that most illnesses of unknown cause are originated from stress. As so, stress has become the cause of many illnesses and many worldwide research topics relate to the connection between stress and illnesses.

Generally, stress refers to all irritations which break the balance of the human body, and which involve physical and physiological alterations. When stress is experienced, firstly the lower part of the brain thalamus which controls the homeostasis of the body recognizes stress. The lower part of the thalamus then immediately stimulates the sympathetic nerve and secretion of the stress hormone(catecholamine) is induced which causes contraction of blood vessels, dilation of the pupil, increase in heartbeat, increase in respiration, temporary halt in stomach activities in the body. Also, the lower part of the thalamus stimulates pituitary body which secretes adrenal cortex hormones causing the

secretion of the cortisol hormone which increases the generation of dextrose in the liver. The increased dextrose and oxygen rush through the contracted blood vessel and are concentrated to the brain and muscles and adequately adapt to the outer irritations but do not reach the peripheral vessels and therefore a chilling phenomenon of the hands and feet is experienced. The pituitary body also intensifies the function of discharging adrenaline into blood. Along with steroid secreted from the adrenal cortex, the adrenaline elevates the stimulation level. All these stress related chemical substances stimulate the nervous system, heart vessels and muscle organs. The foregoing responses from temporary stress are natural, but if stress persists, especially if it is mental stress, it can cause fatal damage to the body.

To resolve the foregoing problems, the present inventor has developed a Stress Resolvable Computer System which is disclosed in Korean Patent Application 99-38330 of September 9th 1999, and said Patent Application is included herein as a part of the present invention.

As shown in figure 1, according to said Korean Application of the present inventor, the execution or control program which is an application program for resolving stress is set up on the computer through a program transmission medium or a remote control device, and the data program prepared at a website is downloaded through a computer network and is made into a complete natural treatment program, and the execution and control program is stored in the execution and control program storage section(210) within the main body(200), the data program is stored in the data program storage section(220), the stress recognition program is stored in the stress recognition program storage section(230), and on computer peripheral devices(300) such as a mouse or keyboard which the computer user uses during work is placed a device through which stress may be recognized through stress recognizing sensor(320) and sensor converter(310) and a stress relieving program is executed according to the stress amount of the user, and thereby when a stress recognition signal is inputted through the peripheral device(300) such as a mouse or keyboard, a signal from

the microprocessor is converted into adequate data and control signal through the converter(110) of output(100), and the sound treatment is outputted through the speaker(130), the color treatment is outputted through the monitor(120), and the scent treatment is executed by spraying fragrance through the spray device(140), and thereby stress may be relieved or resolved. The speaker and monitor may be devices already known, and the spraying device, for example, may utilize Patent Application 00-27636 dated May 23rd 2000 of the present inventor.

Namely, in the stress relievable computer system which is able to automatically recognize stress, stress recognition sensors(320) that are able to sense the stress of the user are adhered on to peripheral devices(300) which the user uses during work, such as a keyboard or mouse, and the state of the body such as pulse rate, body temperature or skin conductivity which are recognized according to the amount of stress are conveyed to the computer or microprocessor through the sensor converter(310) and the stress relieving program is made to operate, and thereby the computer user may handle stress from computer use and in turn elevate the efficiency of work.

In addition, although it may be different for individual persons that are experiencing stress, there may be symptoms of decrease in concentration, difficulty in making simple decisions, loss of confidence, easy irritation or frequent anger, anxieties and uneasiness, increase or decrease in appetite, irrational fear or sudden spasm, arteriosclerosis, sterility. Also, the nervous system and internal secretion system are closely related to coping of stress responses and this may be observed through various physiological signals.

On the other hand, there are countless number of ways to determine information on the human body and also countless number of devices and instruments for determining the information. However, these simple determine the information and do not efficiently utilize the same.

As one aspect, there are many portable devices manufactured for people to comfortably use, but the people who actually make the measurements such as pulse rate simple make a random judgment after looking at the result since it

is difficult for ordinary persons to determine the amount of stress experienced. Namely, some measurement devices make an error of simply measuring the pulse rate of a person and converting the change in pulse rate into a stress index. As another aspect, some devices collect several body related information but are very complicated and use devices of high price and therefore they have developed as devices that ordinary persons, especially computer users may not realistically utilize.

【Summary of the Invention】

The object of the present invention is to provide a peripheral device of a computer(especially a mouse) for automatically recognizing stress which is used in the foregoing stress relieving computer system or a computer automatically recognizing the present stress index of the user and warning the user, that is related to a system in which during computer usage while maintaining contact with the mouse, body temperature, pulse, skin conductivity and/or muscle conductivity is determined directly from the mouse and respective numerical values of the information is sent to the CPU, which is built-in in the mouse, wherein the information is measured, determined and memorized, and the measured data is finally received into the computer main body and respective information along with a synthetic interpretation made to show the amount of stress or fatigue is displayed on the monitor.

The present invention senses information of the body namely body temperature, pulse rate, skin conductivity, along with perspiration amount, muscle conductivity, blood flow, blood pressure, PO2 while the hand is in contact with the mouse during computer use through a sensor mounted on the surface of the mouse, and displays this information on the monitor and at the same time interprets the body related information to check the amount of stress or fatigue.

In conclusion, the first object of the present invention is to measure information on the body and check the amount of stress or fatigue. The present system which is designed to allow easy and convenient measurement while ordinary people are using the computer, is able to obtain various information on the body

and determine synthetic data, that is, whether or not stress is existent through this information.

The second object of the present invention is to basically check the amount of stress or fatigue from underneath the functions of peripheral devices such as a mouse. While businessmen and students who spend numerous hours in front of the computer are using the computer they may check the state of their bodies at anytime.

Another object of the present invention is to provide a computer mouse which may measure the utmost trustworthy stress measurements by adding a simple a device.

To achieve the above objects the stress measurement system using a computer which is one of the aspects of the present invention comprises a computer peripheral device(300) including a body information measuring section which measures the body information of the computer user, a means(400) for signal processing said measured body information, and a means(800) for transmitting said signal processed body information signal to the main body of the computer; and a computer main body(200) provided with a stress recognition program which computes body information alteration coefficients from said transmitted body information signal and assigns weighted values to each coefficient and calculates to compute the stress index.

Preferably, said body information measuring section includes at least a skin conductivity measuring section and a pulse measuring section, and more preferably, said body information measuring section further includes a body temperature measuring section and a muscle conductivity measuring section.

In addition, said signal processing means preferably includes a converting means(420) for A/D conversion of the detected body signal, a means(430) for temporarily storing the detected body signal information, and a controller(410), and said stress recognition program more preferably includes a stress index indicator which allows display of the computed stress index.

In addition, said computer main body includes a stress recognition

program processor(260) in addition to a windows program processor(250) for processing general computer in/outputs, and may be further provided with a device driver(240) which switches the input data which is inputted from the peripheral device to the stress recognition program if the inputted data is body information.

To achieve the above objects the computer peripheral device which is another aspect of the present invention comprises a computer peripheral device including a body information measuring section which measures the body information of the computer user, a means(400) for signal processing said measured body information, and a means(800) for transmitting said signal processed body information signal to the main body of the computer, said body information measuring section including a skin conductivity measuring section(500;500') and a pulse measuring section(700;700'), said skin conductivity measuring section including a first electrode(501) for authorizing a testing signal to the skin, a second electrode(502) for sensing the body information signal from the skin and output(570;570') for outputting the sensed signal from the second electrode to the signal processing means(400), said pulse measuring section including a light emitter and receiver(710), an amplifier for amplifying and outputting the signal detected from said light receiver and a comparator(790) for comparing said amplified signal with reference voltage(Vref) and digitalizing and counting the signal.

Preferably, said peripheral device is a device having a pointing means such as a mouse.

【Brief Description of the Drawings】

Figure 1 is a block diagram showing a stress recognition scent generating computer system related to the present invention,

Figure 2 is a structural diagram of an automatic stress recognition mouse according to a preferred embodiment of the present invention,

Figure 3 is a block circuit diagram of an automatic stress recognition mouse according to a preferred embodiment of the present invention,

Figure 4 is a detailed circuit diagram of the signal processor and

transmitter of figure 3,

Figure 5a to figure 5d are detailed circuit diagrams of the skin conductivity/muscle conductivity measuring section of figure 3,

Figure 5e is an equivalent circuit diagram of figures 5a to 5d,

Figure 6 is a detailed circuit diagram of the body temperature measuring section of figure 3,

Figure 7a to figure 7d are detailed circuit diagrams of the pulse measuring section of figure 3.

Figure 8 is a structural diagram of the stress recognition program of figure 1,

Figure 9 is example diagram of the computer monitor displaying the stress information determined by the present invention,

Figure 10 to figure 12 are circuit diagrams showing another example of the stress measuring mouse related to the present invention wherein, figure 10 is a pointing function and control section of a conventional mouse, figure 11 is a skin conductivity measuring section, and figure 12 is a pulse measuring section,

Figure 13 is a wave diagram of the comparator input/output signal,

Figure 14 is a schematic diagram showing the processing of the mouse signal,

Figures 15a and 15b are structural diagrams of the mouse signal data in figure 14, wherein figure 15a is an example of the data showing the mouse point signal, and figure 15b is an example of the data showing the body measurement signal,

Figure 16 is a flow chart showing the mouse operation of the preferred embodiment of figure 12 to figure 14,

Figure 17 is a subroutine diagram showing the interpretation and transmission action for body information of figure 16,

Figure 18 is a block diagram of the total experimental test of the stress measurement mouse according to the present invention,

Figure 19 is a computer screen showing an example of the calculation test stimulation program used in the experiment of figure 18,

Figures 20a and 20b are flow charts respectively showing progress process of the calculation test experiment and CPT experiment,

Figure 21 depicts the physiological signal collected from an experiment,

Figure 22a and 22b are examples of the question sheets used in figures 20a and 20b, and respectively are examples of subjective evaluation sheets of mental stress and physical stress,

Figure 23a and 23b are examples of heartbeat number and GSR analysis program, respectively, and

Figure 24a to figure 24c show the alterations in heartbeat number, GSR and skin temperature according to time in the calculation and CPT tests.

<Explanation of reference numerals in the drawings>

100 : output　　10 : converter
120 : monitor　　130 : speaker
140 : spraying device　　150 : tactual stimulation device
200 : computer main body
210 : execution and control program storage
220 : data program storage
230 : stress recognition program storage
231 : body signal alteration coefficient computing section
236 : calculator　　237 : stress index indicator
240 : device driver　　250 : window program processor
260 : stress recognition program processor
300 : computer peripheral devices　　310 : sensor converter
320 : stress recognition sensor
330 : X-Y axis direction movement detector
340 : switcher section
350 : Z-axis direction movement detector
360 : operation indicator　　370 : transmitter

400 : signal processor 410 : controller
420 : A/D converter 430 : EEPROM
500, 500' : skin conductivity/muscle conductivity measuring section
510 : D/A converter 520 : timer
530, 530' : first amplification section
540 : second amplification section 550 : bias section
560 : muscle conductivity signal output
570, 570' : skin conductivity signal output
580 : buffer 590, 590' : relay
600 : body temperature measuring section
610 : base signal generator 620 : comparator
630 : offset adjustor 640 : amplification section
700 : pulse measuring section
710 : light emitter and light receiver
720, 720' : first amplification section
730 : first filter 740 : second filter
750, 750' : second amplification section
760 : trigger circuit 770 : third amplification section
780 : warning section 790 : comparator
800 : transmitter
910 : computer monitor 920 : BIOPAC
930 : MP100WS program 940 : analysis device

【Detailed Description of the Preferred Embodiments】

One preferred embodiment of the present invention is described hereinafter with reference to figure 2 to figure 9.

Figure 2 and figure 3 are structural diagrams of an automatic stress recognition mouse according to one preferred embodiment of the present invention.

According to figure 2, a sensor which is able to check various body information on respective portions of the body when the mouse(320) is held is installed. For example, a pulse measuring sensor(322) for the portion where the

end of the thumb contacts, a body temperature sensor(323) for the portion where the middle of the palm contacts, and to measure skin conductivity and/or muscle conductivity of the user a skin conductivity/muscle conductivity measurement sensor(321) comprising a first and second electrode is installed where the end of the index finger or the middle finger(or the ring finger) contacts to click the key of the mouse. Other than the circuit installed to function as a general peripheral device(a mouse herein) the interior of the mouse installs an electric circuit(311) which is able to recognize body information regarding the present invention and signal process the body information signals.

Figure 3 is a block circuit diagram of the automatic stress recognizing mouse according to one preferred embodiment of the present invention. The electric signal from the pulse measuring section(700), body temperature measuring section (600) and skin conductivity/muscle conductivity measuring section (500) respectively connected to the pulse measurement sensor, body measurement sensor and skin conductivity/muscle conductivity measurement sensor of said mouse is inputted into A/D converter(420) of the signal processor(400) and converted to a digital signal and is appropriately processed at the signal process and controller(410), and then is inputted into the microprocessor of the computer main body through the transmitter(800), and is outputted on the monitor and thereby the present state of stress is informed to the user. Therefore, taking a rest is recommended to the user or an appropriate screen or sound or scent is generated or the touching sensation of the user may be stimulated to relieve stress and thereby ultimately reducing stress. Here, the output of said A/D converter(420) is temporarily stored in the EEPROM(430) and is allowed to be reused when needed or after power failure. Also, among the outputs of said pulse measuring section(700) the timer value(described later) which does not digital conversion is transmitted directly to the signal process of controller(410) and the terminal(INT0) of the control chip(IC1)(refer to figure 4).

Figure 4 is a detailed circuit diagram of the signal processor(400) and transmitter(800) of figure 3. The measured outputs of pulse measuring

section(700) and body temperature measuring section(600) and the output of the skin conductivity/muscle conductivity measuring section(500), to be described later, is converted into a digital signal which the controller(410) is able to handle through an A/D converter(for example, MAX186(AD1) is used)(420), and the converted digital signal is inputted through the first input/output terminal(P1.0 to P1.7) to the signal process and controller(for example, 89C52(IC1) is used) and is signal processed, and then is transmitted to the computer main body through the transmission terminal(TXD)(801) by a transmitter(for example, MAX232C (U1) is used)(80). Meanwhile, the control signal from the computer main body is inputted to said processor(IC1) through said reception terminal(RXD)(802) and via said transmitter(800). On the other hand, at the EEPROM(for example, 93C46(U2) is used) of the temporary storage(430) the digital data of the A/D converter is temporarily stored, and this for the reused thereof by the controller(410) when wanting to use past data or during power failure. For the convenience of description, the descriptions regarding the accompanying clock signal generator(Y1) and reset signal generator(U1) of said processor, and the circuit elements(C1-C10,R1) which are used accompanying said respective chips and authorized voltage is omitted.

Figure 5a to figure 5d are detailed circuit diagrams of the skin conductivity/muscle conductivity measuring section(500) of figure 3.

As depicted in figure 5a, the second input/output terminal(P0.0 to P0.7) of the control processor(IC1) of said controller(410) is connected to the input terminals of a Darlington driver(for example, ULN2803(U3) is used) which serves as the timer(520), and the output terminals of said chip are connected to relay terminals RY1 to RY7, for example, to measure skin conductivity every five seconds the relays(RLY_1 to RLY_7) are switched every five seconds. Between each output terminal of said Darlington driver and the relays diodes(D1-D7) are connected in parallel connections for stable control.

Meanwhile, the third input/output terminals(P0.0 to P0.7) of said control processor(IC1) are connected to the input terminals of the D/A converter(for

example, DAC0808(DA1) is used) through the parallel connection array resistor(AR1), and the digital signal outputted is converted to, for example, a sine wave analog signal by the D/A converter(510), and then is authorized to the second and third relays (RLY_2 and RLY_3)(refer to figure 5b) as a testing signal. However, as shown in figure 5b, the output analog signal of said D/A converter(510) is amplified by the first and second amplification sections(530, 540), and is authorized after being adjusted to the suitable operation bias voltage by the bias(550). For the convenience of description, descriptions of the circuit elements(R2, VR1, C11) accompanying the D/A converter chip and recommended excitation is omitted, and the first and second amplification sections(530, 540) may be embodied using the known amplification circuit which uses the operational amplifiers(OP1, OP2), resistors and capacitor elements(R3-R5, C12-C14), and the bias section (550) may also be embodied using the known bias resistor(R6, R7), and therefore the detailed description thereof is omitted. However, the bias resistor is preferably selected such that the operational bias voltage is 1.2V.

The outputted analog signal(Vout) is authorized to the input(COM_2)of the first and second relay(RLY_2, RLY_3), and the output(NO_2) of the said second relay is again connected to the input(COM_1) and the first electrode(501) of the seventh relay(RLY_7), and the output(COM_2) of said third relay is again connected to the input(NO_1) and the second electrode(502) of the sixth relay(RLY_6). Meanwhile, the first and second electrodes(501, 502) are connected to the first and second input terminals(COM_1, COM_2) of the first relay(RLY_1), the first and second output terminals(NO_1, NO_2) corresponding to each input terminal is connected to the input(D, E) of the muscle conductivity signal output(560). Also, said first and second electrodes(501, 502) are respectively connected to the input terminal(COM_1) of the fourth and fifth relay(RLY_4, RLY_5), and the output(NO_1) of said fourth relays and the inverted output(N.C.) of the fifth relay are connected to the inputs(F, G) of the skin conductivity signal output(570).

As the detailed circuit diagram of the muscle conductivity signal output(560) is depicted in figure 5c, it is comprised of an amplification section(R8-R18, C15-18, OP3-OP5), filter section(R19-R24, C19-C26, OP6-OP7) and amplification section(R26-R28, C27-C28), and the final detected signal is connected to the A/D converter(AD1) through the terminal(MUSCLE)(503).

As the detailed circuit diagram of the skin conductivity signal output(570) is depicted in figure 5d, at the inputs(F, G), the current(i1, -i2) which flows in the first and second electrodes respectively flows, and at the contact point the signal which is the difference in the two currents(i1-i2) is inputted. Said input signal is inputted into a buffer(580) comprised of a diode limiter(D9, D10), potential resistor(R29, R30) and voltage follower(OP9), and the buffer again is connected to the amplifier circuit(R31-R33, C91, OP10). The amplified final detection signal is connected to the A/D converter through the terminal(SKIN)(504). For reference, a capacitor is not necessary at the RC parallel circuit(R33, C91) where there is feedback from said amplifier circuit, but it is preferable for stopping high frequency noise and oscillation in the RC parallel configuration.

Figure 5e depicts the equivalent circuits of said figures 5b to 5d. Referring to figure 5e, the operation of said skin conductivity/muscle conductivity measuring section(500) is described. For testing the analog signal inputted from the D/A converter(510) is amplified and bias adjusted(530-550), the amplified and adjusted signal(Vout) is authorized to the first or second electrode(501,502) according to whether or not it has been switched at the second and third relays(RLY_2, RLY_3). The current from each electrode is authorized only to the skin conductivity signal output(570) through the fourth and fifth relays(RLY_4, RLY_5) in case the first relay (RLY_1) is open, and the difference(i1-i2) of the current signal measured from the two electrodes is amplified and is authorized to the A/D converter(420) through the skin conductivity measurement terminal(504), and in case the first relay(RLY_1) is on and the fourth and fifth relays(RLY_4, RLY_5) are off, the signal measured

from the two electrodes is authorized only to the muscle conductivity signal output(560), and is amplified and filtered and authorized to the A/D converter(420) through the muscle conductivity measurement terminal(503).

That is to say, the amplified and bias adjusted signal is inputted into the second relay chip (RLY_2), and the output of said relay chip is again inputted into the seventh relay chip(RLY_7), and said second and seventh relay chips intermittently switches the inputted analog signal according to the switching signal of the second relay terminal(RL2) and seventh relay terminal(RL7), and detects the resistance signal of the first electrode. Meanwhile, after said converted analog signal is amplified and bias adjusted, it is also inputted into the third relay chip(RLY_3), and the output of said third relay chip is again inputted into the sixth relay chip(RLY_6), and said third and sixth relay chips intermittently switches the inputted analog signal according to the switching signal of the third relay terminal(RL3) and sixth relay terminal(RL6), and detects the resistance signal of the second electrode. Because the detected signal of said first electrode and second electrode is bridged by the first relay chip which operates according to the first relay, the detected signal of said first electrode and second electrode is connected to the fifth and fourth relay chips which are operated according to the fifth and fourth relay electrode signal, and therefore at the contact point of where the output terminal(N.C.) of said fifth relay chip and the output terminal(NO_1) of said fourth relay chip connect, the difference signal of said first electrode and second electrode is authorized. Said difference signal is connected to another amplifier through the buffer, and the signal amplified by said amplifier detects the characteristics of skin conductivity and is inputted into said A-D converter.

Finally, said signal is temporarily stored in the EEPROM(420) and at the same time, is signal processed by the signal process and controller(410), and is transmitted to the computer main body by the transmitter and thereby enables periodic checking of the body index which enables detecting of the stress state of the computer user and the displaying thereof through the monitor.

Figure 6 is a detailed circuit diagram of the body temperature measuring section(600) of figure 3. As depicted in figure 6, the body temperature measuring section(600) is embodied by the signal measured by the body temperature measurement sensor(THERMIST)(601) being compared with a base signal generated from the base signal generator(610) by the comparator(620) and amplified. The base signal generator(610) comprises a zener diode(ZD1) serially connected to a resistor(R34) and parallel connected to a capacitor(C29), a variable resistor(VR2) connected to a resistor(R35) and another resistor(R36), and the comparator(620) composed of operational amplifier(OP11), a resistor(R37) connected to the base signal generator(610) and the input terminal of the inverted end of the operational amplifier, a resistor(R38) connected to the body temperature measurement sensor(601) and the input terminal of the non-inverted end, a condenser(C30), and a resistor(R39) composing a feedback loop.

The amplified signal is offset-adjusted by the offset adjuster comprising a variable resistor(VR3) and resistors(R41,R42), and is amplified by the common amplifier(640) comprising an operational amplifier(OP12), input end resistor(R40), and a feedback RC parallel circuit(R43, C92), and then is inputted into the A/D converter(420) of the signal processor(400) through the body temperature measurement terminal(TEMP)(602) and is processed as the skin conductivity measurement signal.

Figure 7a to figure 7d are detailed circuit diagrams of the pulse measuring section(700). As depicted in figure 7a, the pulse measuring section(700) comprises a light emitter and receiver(710), a first amplification section(720), first and second filters(730,740) depicted in figure 7b, connected to the output end(A) of said first amplification section, a second amplification section(750) depicted in figure 7c, connected to the output end(B) of said second filter, a trigger circuit(760) depicted in figure 7d, connected to the terminal C of said second amplification section, and a third amplification section(770).

In more detail, as shown in figure 7a, a fixed level of light is emitted by the LED(701) of the light emitter and receiver, and the light emitted from

said LED is received by the photo transistor(PHOTO TR)(702). Here, the brightness of the light received is altered as the surface area or pressure of the finger contacting the mouse is altered by the pulse of the finger, and thereby the emitted light from the LED is read differently by the light receiving element, and therefore easy detection of the pulse is enable by reading the above alterations. Resistors R44 and R45 are bias resistors.

The signal received by the receiving element(702) is amplified by the first amplifier(720), and the first amplifier is composed of an operational amplifier(OP13) comprised by the input end on one side thereof being connected to the receiving element(702) through a coupling capacitor(C31), bias resistors(R46 to R48), and a feedback condenser(C32).

Said first amplification section(720) is connected to terminal A through first and second filters(730,740), and the amplified measurement signal which passes through terminal A is filtered by the second filter(740) which is connected by the first filter(730) and the coupling resistor(R55), and is soon amplified again by the second amplification section(750) which is connected continually through terminal B(refer to figure 7c), then is inputted into the A/D converter(420) of the signal processor(400) of the next end through the coupling capacitor(C25) and pulse measurement sensor(PULSE)(703). The input to one side of said second amplification section(750) is preferably offset-adjusted by the variable resistor(VR4). Also, the reason for said filtering is to filter the light from the computer monitor or fluorescent lamps(for example, 60hz illuminations) to allow response to only the specific wave lights from said LED(701).

As the first amplification section(720), said second amplification section(750) also comprises an operational amplifier(OP14) connected to terminal B through a coupling capacitor(C33), bias resistors(R49-R50), and RC parallel circuit(R48 and C32, R51 and C34) which compose a feedback loop. However, as mentioned above, the input end on one side of the second amplification section is connected to the offset adjustment circuit(VR4). Also, said first and second filtering circuits(730, 740) may be comprise resistors(R52-R54, R56-R58),

condensers(C36-C39, C40-C43), and amplifiers(OP15, OP16) of the known method.

Meanwhile, a Schmidt trigger circuit(760) as shown in figure 7d is provided on the output terminal(C) of said second amplification section(750) such that said received light may be selectively measured at a fixed periodic time, and therefore limiting the waves that exceed a predetermined peak value among the measured pulse measurement signal, then by counting the number of the above waves within a predetermined time(for example, one minute), the pulse number may be computed. As depicted in figure 7d, the Schmidt trigger circuit(760) has the signal of the amplifier circuit(C44, R59, Q1) which amplified the pulse measurement signal of connection terminal C as input, and comprises resistors(R60-R61, C45) which are connected in company with the timer(for example, HAI7555(U5) is used) which generates the limiting signal output, and the output thereof is again amplified by the amplifier circuit(770) which comprises resistors(R63-R64), a condenser(C46) and a transistor(Q2), and then is directly inputted into the input terminal(INT0) of the signal process and controller(410) without passing through the A/D converter. To warn the computer user while counting the pulse number, on the Schmidt trigger circuit, warning elements(LED, R62)(780) are parallel connected.

The operation of the above mentioned stress measurement device is described hereinafter with reference to figure 1 to figure 4 and figure 8 to figure 9. Figure 8 is a structural diagram of the stress recognition program related to the present invention, and figure 9 is an example of a computer monitor screen displaying stress information measured according to the present invention.

First of all, when the computer user touches the peripheral device with the body(for example, holds the mouse with the right hand and contacts the respective body signal measurement sensors of figure 2), the pulse, body temperature, and skin conductivity/muscle conductivity values of the computer user are measured by the pulse, body temperature, and skin conductivity/muscle conductivity measuring sections at fixed intervals(for example, five second intervals), and the measured pulse, body temperature, and skin

conductivity/muscle conductivity values, which are body signals, are inputted into the A/D converter(AD1) through input terminals(CH0-CH3), as shown in figure 3 and figure 4, and are converted into digital values, and then are inputted into the processor(IC1) of the controller(410) through the output terminal(Dout) and at the same time are temporarily stored at EEPROM(U2), and then are transmitted to the computer main body(200) through transmitter(800). Said transmitted signal allocates 4bits per body signal and may be comprised of 16bits. However, because skin conductivity comparatively reflects stressed state better than muscle conductivity, muscle conductivity measurement and muscle conductivity alteration coefficient computation may be skipped, and in this case the transmitted signal is comprised of 12-bit data.

The measured pulse, body temperature, and skin conductivity of the computer user are continuously measured at a one-week or one-month interval, and the criterion stress value of the user is generated. Therefore, this criterion value may differ by the user or age.

The data transmitted to the computer main body(200) is analyzed by the stress recognition program stored within the stress recognition program storage(230)(refer to figure 1), and as figure 8 is a structural diagram of the stress recognition program, the stress recognition program according to the present invention is composed of a computing section(231) including pulse change coefficient(α) computing section(232), body temperature change coefficient(β) computing section(233), skin conductivity change coefficient (γ) computing section(234) and muscle conductivity change coefficient (γ) computing section (235), a calculating section(236), and a stress index indicator(237).

At the pulse change coefficient(α) computing section(232), body temperature change coefficient(β) computing section(233), skin conductivity change coefficient (γ) computing section(234) and muscle conductivity change coefficient (γ) computing section (235) within the body signal change coefficient computing section(231), the pulse change coefficient(α), body

temperature change coefficient(β), skin conductivity change coefficient (γ) and muscle conductivity change coefficient (γ) are computed by the respectively transmitted 4-bit body signal data, and for example, the equation made by computing a criterion value for a specific person is as the following.

【Equation 1】

$$\alpha = 60000 \times \frac{11.0592}{12P} \,[pulses/\mathrm{min}]$$

(wherein, P is the 4-bit pulse measurement value)

【Equation 2】

$$\beta = \frac{(110.48 - \sqrt{110.48^2 + 4 \times 0.8139 \times (505.5 - T)}}{2 \times 0.8139} + 9[^\circ C]$$

(wherein, T is the 4-bit temperature value)

Also, the skin conductivity and muscle conductivity values(γ , δ) are values spanning from 0 to 4095 and may be programmed to be artificially selected.

Next, at the calculating section(236), as the body change coefficients computed by said equations and computing methods are combined and the stress index(ST) is finally calculated, to reflect the importance that each of the change coefficients have on the actual stress weighted values are multiplied to each coefficient then combined as equation 2.

【Equation 3】

$ST = a\alpha + b\beta + c\gamma + d\delta$ (wherein, a, b, c and d are weighted values)

An example of the above computed body change coefficients, namely the pulse change coefficient(α : Pulse), body temperature change coefficient(β : Temp), skin conductivity change coefficient (γ : GSR) and the stress index(ST: Stress) displayed on the monitor by the stress index indicator(237) is shown in figure 9. In the preferred embodiment of figure 9, because of the above-mentioned reason the muscle conductivity value has not been considered. The above computed

stress index(ST) displays the stress indexes of the past one-week in a bar chart, and the stress indexes of the past one month in a bar chart, and allows the user to check the alterations in the current stress state.

Therefore, in case the computer user is determined to be experiencing stress, an appropriate stimulant is applied to the user or a warning is shown on the monitor to allow the user to personally stop working and call the user to attention which ultimately enables stress relief or resolving of the user.

For example, the recent one week or one month of stress is compared, for convenience, the states are classified into A: normal state phase B: some stress phase and C: much stress phase and long rest is necessary, states, and in the case of state B and C a scent spray device(140) is automatically activated, but activation may be programmed such that for state B the spray amount is 0.2 and spray amount is 0.4 for state C.

On the other hand, figure 10 to figure 17 shows another preferred embodiment of the automatic stress recognition device of the present invention applied to a computer mouse. Figure 10 is a circuit diagram of the pointing function and controller of a conventional mouse, and figure 11 is a circuit diagram of the skin conductivity measuring section, and figure 12 is a circuit diagram of the pulse measuring section.

As depicted in figure 10, the conventional light mouse, which is three-dimensional pointing enabled, comprises a X-Y axis direction movement detector(330) comprising a light emitter/receiver (R101, D101, Q101) and a movement detection signal processor(U101, XT101, C101-C103, Q102), a switch section(340) having three switch inputs(SW1-SW3), a Z axis direction movement detector(350) having an encoder(ENC1) which detects rotation of the wheel, a operation indicator(360) having light emitting diodes(D102, D103) which inform whether or not the mouse is operating, a transmitter(370) which sends and receives data with the computer main body, and a processor chip(IC2) which controls the above and accompanying circuit elements(R102-R110, C104-C105, D104, XT102). Here, said processor chip(IC2) is circuit of the signal processor(400) of figure 4 made

into one chip, and includes the A/D converter and controller and the like, and besides X-Y axis direction and Z axis direction movement detection and pointing control function, it has the function of detecting skin conductivity and pulse rate. Said light mouse is compliant to for example, the IBM protocol(P/S2).

For the above, the processor chip(IC2) sends a testing signal to the input end(R112) of the skin conductivity measuring section(500') and receives the measured signal from the output end(OP10) of said skin conductivity measuring section(570') through the A/D converter of the processor chip(refer to figure 11). Also, it receives the detection signal of the pulse detector(700') from the terminal C through the A/D converter within the processor chip(IC2), and receives the comparative signal(described later) of the measured pulse signal through a timer within the processor chip(IC2)(refer to figure 11).

The skin conductivity measuring section(500') according to the second embodiment of the present invention is described hereinafter with reference to figure 11. As shown in figure 11, the on/off signal generated from the processor chip of the signal processor is connected to the base end of the switching transistor(Q103) through the resistor(R111) and controls the actuation of the relay(590).

Meanwhile, the signal from said processor chip is amplified by the amplification section composed of a amplifier(OP1) and resistors(R112,R114), and then is inputted into one terminal(NO_1) of the relay(RLY_1) through the output resistor(R114). Another terminal(COM_1) which matches said terminal(NO_1) is connected to a first electrode(GSR1)(501). On the other hand, on the second input/output terminals(NO_2, COM_2) which correspond to the matching terminals(NO_1, COM_1) a second electrode(GSR2)(502) and output(570') is connected.

Therefore, in case the on/off signal from the processor chip is on, the amplification section(530') which functions as an input is connected to the first electrode(501) and voltage of a number of volts applied to the human body, and this induced a current to flow of which the amount corresponds to the skin

conductivity of the computer user, and at the same time the second electrode(502) connected to the output(570'), and therefore the detected skin conductivity output signal is transmitted to the A/D converter of the signal processor chip(IC2) through the output(570') composed of a buffer(580') and amplification section. The output(570') and buffer(580') of said second preferred embodiment are almost identical to the skin conductivity signal output(570) and buffer(580) of the first preferred embodiment as depicted in figure 5d, and the constituting circuit elements are also identical, and therefore circuit elements having like functions are indicated with like reference numbers. However, in the first preferred embodiment the inverted input terminal of the amplifier circuit is connected to earth, but the only difference in the present preferred embodiment is that it is connected to a low voltage of 2.5V.

Next, the pulse measuring section(700') according to the second preferred embodiment of the present invention is described hereinafter with reference to figure 12. As depicted in figure 12, the pulse measuring section(700') according to the second preferred embodiment of the present invention also comprises a light emitter and receiver(710'), a first amplification section(720'), a second amplification section(750') connected to the output end(A) of said first amplification section, and a comparator(790) connected to the output terminal of said second amplification section. Namely, in comparison to the pulse measuring section(700) of the first preferred embodiment, the pulse measuring section(700') of the second preferred embodiment does not use the filters(730, 740), and first amplification section(720') is simply directly connected to the second amplification section(750').

The light emitter and receiver(710'), first amplification section(720') and second amplification section(750') of the pulse measuring section(700') of the second preferred embodiment is also identical to those(710, 720, 750) of the first preferred embodiment, and the constituting circuit elements are also identical and therefore for circuit elements of like functions are indicated with like reference numbers. However, in the first preferred embodiment the inverted

input terminal of the first and second amplification section is connected to earth, but the only differences in the present preferred embodiment are that they are connected to a low voltage of 2.5V, and that on the inverted input terminal of the second amplifier circuit of the second preferred embodiment a variable resistor(VR4) for offset adjustment is not used.

The output signal of the output end(C) of said second amplifier(750') is also transmitted to the A/D converter of the signal processor chip(IC2).

The operation of the second preferred embodiment of the present invention is described with reference to figures 14 to 17. Figure 13 is a wave diagram of the input/output signal of the comparator of figure 12, figure 14 is a schematic diagram of the processing of a mouse signal, figure 15a and figure 15b is a structural diagram of the mouse signal data of figure 14, where figure 15a is an example of the data showing the pointing signal of a mouse and figure 15b is an example of the data showing the body measurement signal.

Meanwhile, as a method of measuring pulse alterations by the detected pulse signal, there is a method of receiving body information at short intervals of time(for example, 1/100-1/200 second) and determining the interval between a maximum value and a following maximum value as one cycle, but as shown in (a) of figure 13 there may be disorder in the wave due to noise. Therefore, as depicted in figure 12, a comparison section(790) having a comparator(OP101) and potential resistors(R115, R116) may be accompanied such that if detected signals are higher than the reference voltage(Vref), 'high' signals are outputted, and if signals are lower than said reference voltage, 'low' signals are outputted, and thereby digital process methods are allowed as depicted in (b) of figure 12, and in this case the pulse counting is not effected even if there is noise generated and an accurate coefficient may be obtained. This digital signal does not need A/D converting and may be authorized directly to the timer within the processor chip(IC2).

In figure 14, a hardware block diagram regarding the process of the signal transmitted to the computer main body from the mouse is depicted. A 4-byte signal

is transmitted from the mouse(300) to a device driver(240) within the computer main body(refer to figure 15). The There are two types of 4-byte signals transmitted to the device driver(240), and this type of data form may be interpreted by the device driver according to the highest bit being "0" or "1". For example, as depicted in figure 15a if the highest bit is "0" then the device driver(240) recognizes the transmitted data as a common point data of the mouse and switches it so that it may be processed in the windows programs processor(250), and the windows program processor(250) may set the next 7 bits as the mouse key state and each following 8 bits as the X, Y, Z axis direction movement values. In case the highest bit is "1", the device driver interprets the transmitted signal as body information and switches the data so that it may be processed in the stress recognition program processing section(260) which is a type of application program, and the stress recognition program processing section(260) may be set such that it interprets the next 7 bits and the next 8 bits(15 bits) as the pulse timer measurement value, and each following 8 bits as the current of the second electrode and the skin conductivity value, respectively(refer to (a) of figure 15a). However, as in the first preferred embodiment of the present invention, in case the body temperature and muscle conductivity value is intended to be measured and stress is intended to be measured by synthesis of the 4 parameters, the next 7 bits after the highest bit may be set as the body temperature, and each following 8 bits as the muscle conductivity, second electrode current and skin conductivity value, as depicted in (b) of figure 15.

In addition, the body information processing method in the stress recognition program processing section(260) is identical to that of the first preferred embodiment. That is, firstly the pulse change coefficient(α) is computed according to the pulse timer value, then the skin conductivity change coefficient(γ) is computed according to the skin conductivity value, and these are combined and the stress index is determined through equation 4.

【Equation 4】

$ST=a\alpha+c\gamma$ (wherein, a and c are weighted values)

In this case, because the skin conductivity change coefficient reflects stress better, preferably a<c preferable. Also, the above computed body change coefficients, that is pulse change coefficient(α : Pulse), skin conductivity change coefficient(γ : GSR) and stress index(ST: Stress) are displayed on the monitor by the stress index indicator(237).

The operation of the second preferred embodiment is described hereinafter with reference to the flow charts of figures 16 and 17. Figure 16 is a flow chart showing the operation of the mouse of figure 12 to figure 14, and figure 17 is a flow chart showing the body information interpretation, transmission. subroutines.

Firstly, as depicted in figure 16, when the mouse operation is started(S1), the processor chip(IC1) conducts initialization(S2) such mouse timer and variable setting. Then, it resets the X-Y axis direction movement detector(330)(S3), and then detects X-Y axis direction movement through the 4 phase signal of the combination of 2 pulse of the X-Y axis direction movement detector, then checks the Z axis direction movement through the output of the encoder(ENC1) according to the rotation of the wheel(S4).

Meanwhile, besides the general operation of the mouse, the mouse of the present invention, checks the communication with the computer at a fixed interval(S5), and if the there is no command input from the computer main body, then sends the mouse data to the computer(S6) since the transmitter may operate in the output mode. However, if command data is inputted, unlike the above case, the data is processed(S7), and the subroutine of figure 17 which interprets and transmits the body information of the computer user is performed(S8).

The subroutine of interpreting and transmitting the body information of the computer user is described with reference to figure 17. When the body information interpretation is started(S11), the processor of the mouse sends a relay 'on' signal to the skin conductivity measuring section(500') at a predetermined interval(for example, 1/100 to 1/200 seconds) and actuates the relay(RLY_1) and authorizes a 1.2V voltage to the first electrode(501) and

receives a current signal through the second electrode(502) and thereby measures the skin conductivity of the body, and also, receives a detected signal through the light emitter and receiver(710) at said predetermined interval through the pulse measuring section(700'). On the other hand, these signals are received into the A/D converter and are digital processed, and the controller interprets these digital values and temporarily stores them in the buffer (S12, S13). In addition, these interpretation and temporary storing stages are repeated for a certain amount of time(S14). Meanwhile, the pulse detection signal is processed into a digital value by the comparison section(790) as depicted in figure 13 and then is directly inputted into the timer and thereby the pulse may counted in the directly in the processor of the mouse, and the timer value is also interpreted(S15). Therefore, this body information are made into a frame as shown in figure 15b, and transmitted to the computer main body(S16). The following process is returning to S4 so that the mouse may resume the original function of pointing(S17). In the process of figure 17, the mouse automatically transmits the body information to the computer main body once the buffer is full, but transmitting the body information in compliance to when the computer main body sends a transmission command is also possible.

In figures 18 to 24c, the experiment method and result data regarding stress measurement with use of the stress measurement device of the present invention is shown to verify that stress measurement according to the stress measurement device method of the present invention a sufficiently trustworthy.

Figure 18 is a block diagram of the overall experimental test of the stress measurement mouse of the present invention, and figure 19 is an example screen of the calculation test stimulation program used in the experiment of figure 18, and figure 20a and figure20b are flow charts showing respective procedures of the calculation test experiment and CPT experiment, figure 21 shows physiological signals collected by the experiment, and figure 22a and figure22b are examples of the question sheet used in figure 20 which respectively are subjective evaluation sheets of mental and physical stress, and figure 23a and figure23b

are respective examples of the heartbeat number and GSR analysis program, and figure 24a to figure 24c respectively show heartbeat, GSR and skin temperature change according to change in time in the calculation and CPT test.

As shown in figure 18, first a sensitivity mouse(300) of the present invention and a biopac(920) device not related to the present invention have been connected to the computer main body(200), where various body information such as PPG, RSP, GSR, ECG, EEG and SKT are computed. At the same time of the experiment, stress has been induced to the experiment volunteers by stimulating them through a separate computer monitor(910), and the body information of the experiment volunteers have been analyzed at a analyzer device (930) according to the MP100WS program(930).

The volunteers of said experiment were ten male and ten female college students of twenty to twenty five years old, and the calculation test and CPT(continuous performance test) have been presented and conducted as the stress stimulants. The physiological signals measured were PPG, RSP, EEG, ECG measured from a biopac device not related to the present invention, and at the same time GSR, pulse signal through the automatic stress recognition mouse of the present invention, and temperature measured by a thermometer.

To find out the actual mental state of the experiment volunteers, a subjective survey on mental and physical have been conducted. Regarding data analysis, parameters were extracted through appropriate analysis tools on each measured physiological signal and were performed to obtain the stress index.

The calculation test method, which is one of the stress stimulation methods, is a method which reflects the regulations of ISO 10075-2, and is a program developed with Visual Basic at the Electronic Engineering college of Jun-buk University, in which volunteers were made to simply add numbers shown on the screen, and if the results were identical to the numbers shown on the screen, they were to press the foot pedal joystick button 1, if the results were different they were to press foot button 2, within three seconds. The additions were fifteen minute of three digit numbers, fifteen minutes of four digit numbers totaling

thirty minutes of stress stimulation. An example of the calculation test stimulation is shown in figure 19.

The CPT(continuous performance test), which is another method of stress stimulation, has been introduced by "Rosvold" in 1956 to detect loss of attention in patients suffering from minor epilepsy, and was utilized in the present research as the requirement of continuous concentration in the experiment may induce mental stress. Every second a number from "0" to "9" randomly appears on the computer screen, among the numbers whenever "0" appears on the screen the volunteer must press the foot button and keep count. The time of number display has been set to 29msec in the case of the horizontal frequency of the computer being 70Hz로. The number of times "0" is displayed is one hundred twenty times among a total of four hundred eighty number displays. The test results are calculated by the ratio(%) of the present stimulation to the stimulation felt by the volunteer. In this case, if concentration is poor in comparison to participation the percentage of the correct answer is very low, therefore the data within a ±10% error range of the CPT is recognized as active concentration and are used in the analysis.

The subjective question sheets on mental and physical stress have been prepared in a 7-point scaling system, with reference to existing thesises and the "Mental Ruler Handbook" edited by the Behavior Science Research Center of Korea University, and are shown in figure 22a and figure 22b.

The sampling frequency of the physiological signals detected through the Biopac device has been set to 512Hz, and the physiological signals through the automatic stress recognition mouse have been stored every one second. The temperature has been recorded every minute according to the readings of the thermometer.

The physiological signals were detected from twenty experiment volunteers, and the same volunteers were stimulated with the calculation test on the first day and the CPT on the second day.

The physiological signal detection time and experiment procedure were

proceeded as figure 20a and figure 20b. As shown in figure 20a, firstly, the experiment purpose and procedure of the calculation test experiment were explained(S21), the electrodes were adhered and adjusted(S22), the physiological signals at the stable state were detected(S23), and the question sheets of the stable state were asked to be written(S24). Next, a task practice on stress application and response was performed(S25), a short recess was taken(S26), after five minutes the actual task was performed(S27), and then the question sheets of the stress state were asked to be written(S28).

Meanwhile, as shown in figure 20b, in the CPT experiment, firstly, the experiment purpose and procedure of the calculation test experiment were explained(S31), the electrodes were adhered and adjusted(S32), the physiological signals at the stable state were detected(S33), and the question sheets of the stable state were asked to be written(S34). Next, a task practice on stress application and response was performed(S35), a short recess was taken(S36), after five minutes the actual task was performed(S37), and then the question sheets of the stress state were asked to be written(S38).

(a) to (e) of figure 21 depicts the representative signals of physiological signal which are, in order, PPG, RSP, GSR, EEG, ECG signals.

Considering the whole experiment time, regarding the stress stimulation time, the calculation stimulation method is thirty minutes, the CPT method is eight minutes, therefore under the assumption that lapse in time acts as a factor of stress and effects physiological signals, the calculation test stimulation data, which was collected for thirty minutes, was divided into ten data pieces of each three minutes and then analyzed, and the CPT data, which was collected for eight minutes, was divided into eight data pieces each of one minute and then analyzed. Therefore, in the calculation test stimulation data according to the lapse in time, the physiological signals changing every three minutes were able to be observed, and in the CPT stimulation data the physiological signals changing every minute were able to be observed. Here, the difference between the calculation test stimulation data and the CPT stimulation data is that in the

calculation test, the stimulation time is thirty minutes which is lengthy, and in the CPT it is short with eight minutes, and the calculation test is a simple mental arithmetic test and therefore the volunteers adapt to the stimulation after a certain amount of time, but in the CPT the degree of stimulation is higher and fatigue of the eyes increase with the passing of time.

In the present experiment, for the analysis of the data the "Labview" program was used. Data processing and Database construction is very easy with this program, and all processes may be composed with graphic program and therefore it is used not only in the field of physiological signal process analysis but in a broad variety of fields.

In the ECG, analysis was made with the heartbeat as a variable, and the change in heartbeat was represented as a percentage against the stable state. This is because the standard state varies in every person and therefore it is impossible to compare data of several people with a simple absolute number. Figure 23a depicts the heartbeat calculation program.

The GSR shows the general changing tendency of the electricity response of the skin, and is used as an index showing the level of the sympathetic nervous system, and may be analyzed by observing the general tendency in a domain of time. In the present research, the average of the amplitude value of the GSR was found and was shown in percentage against the stable state. Figure 23b depicts the GSR program used in the experiment.

The EEG is analyzed through frequency analysis, the frequency range is divided into δ wave(under 4Hz), θ wave(4~8Hz), α wave(8~13Hz), β wave(over 13Hz), then the power value for each range is found and $\alpha/(\alpha+\beta)$ is calculated and is expressed in percentage against the stable state in each time zone.

The RSP was used for breath measurement by detecting the change in resistance that changes with the change the thorax muscles which contract and expand when breathing and was used to observe the elevation in breathing incurred from stress by analyzing the peak value of the wave during in and out-take or

the number of breaths taken. In the present experiment, the number of breaths is found and was expressed in percentage against the stable state.

Skin temperature has the tendency to decrease due to contraction of blood vessels when the sympathetic nerves are active. The skin temperature data was also expressed in percentage against the stable state.

Regarding the data from the subjective survey, the points checked for each volunteer was averaged and a comparison was made between the stable state and the stimulated state.

The survey results were analyzed to check if the stimulation method of the present experiment was appropriate in inducing stress, in the calculation test, among the twelve questions regarding mental stress, excluding the 'head feels light' and 'feel bored', the rest of the questions became more extreme after the stimulation than before the stimulation, and among thirteen questions regarding physical stress, excluding 'feel spasms on eyelids', 'feel sleepy' and 'eyes are tired', the rest of the questions became more extreme after the stimulation than before the stimulation. In the case of the calculation test, the time taken to detect the stable state physiological signal is ten minutes and during that time one stares at one place and so he/she may be bored before receiving stress stimulation. Also, in the thirty minutes of the calculation test one continuously gazes at the 4-digit numbers on the screen and conducts mental arithmetic and therefore there has been some movement of the eye and that may be seen as why the eye may be less tired.

In addition, special notice should be taken to the fact that large changes have been made to 'feel nervous', 'feel irritated', 'become angry' in the mental stress, and in the physical stress, large changes have been bade in 'shoulders are sore', 'mouth feels dry', 'arms and legs ache'. This shows that the calculation test does induce stress to the experiment volunteers and means that if physiological signal changes according to lapse in time are found, they may be utilized as an index of the level of stress.

In the CPT test, for the mental stress, excluding 'feel bored', the rest

of the questions became more extreme after the stimulation than before the stimulation. For the physical stress, excluding 'feel sleepy', the rest of the questions became more extreme after the stimulation than before the stimulation. The reason behind the 'feel bored' and 'feel sleepy' item may be explained with the same reasons as the calculation test. However, the item of 'eyes feel tried' show different results before and after the stimulation between the calculation test and the CPT stimulation, the reason being that in the thirty minutes of the calculation test the volunteers look at the screen and mentally calculate the 3-digit, 4-digit numbers which applies less amount of fatigue to the eyes, but in the case of the CPT, the stimulation itself is instantly distinguishing numbers flashing in a short amount of time which would apply much more fatigue to the eyes, that is why the CPT stimulation would have aggravated the eyes more from the stable state.

The graphs of averages of the percent change rates of the heartbeat numbers for the calculation and CPT tests are shown in figure 24a. Each value of the graph expresses the percent increase amount with the heartbeat number of the stable state before the stimulation as the reference, and it can be seen that during the stimulation the heartbeat number has increased overall in comparison to the stable state. In the case of the calculation test calculation test, it can be seen that the heartbeat number has the tendency to increases the most as the difficulty of the test increases at the eighteen minute mark when the first level(3 digits) stimulation ends and the second level(4 digit) stimulation begins. Also, in the CPT test stimulation, in the initial stage there is some increase and the maximum change is displayed at the 6-minute mark. This can be interpreted to be that at the beginning of the stimulation, there is some increase in comparison to the stable state due to nervousness, and after some time lapses one adapts to the stimulation then feels more mental burden as more time lapses.

Therefore, the stress was classified into three phases of 1, 2, 3 according to the change in heartbeat. Firstly, in the case of the calculation test, the maximum stress at the 18-minute mark which is the starting point of

the second level(4 digits) was set as the phase 3 stress, and the phase 2 and phase 1 values were set as value 50% and 25% of the 3 phase value. In the case of the CPT, the maximum stress at the 6-minute mark was set as the phase 3 stress, and the phase 2 and phase 1 value were set as the case of the calculation test. That is, setting the stable state as the reference, when the increase in heartbeat is as Table 1, the stress has been classified into respective phases.

Next, conducting an analysis on the GSR measurement experiment, although the calculation test is carried on for a long amount of time, because of the characteristics of the stimulation, it is difficult to conceive the stress to be continuous, and as time passes the experiment volunteers exhibit characteristics of adapting to the stimulation. Therefore, the GSR concluded to show decrease with the lapse of time instead of increase. As with the CPT stimulation, although the time is short, because the same stimulation is repeatedly presented, the eyes may get tired but nervousness showed tendencies of decrease. The average GSR responses of the two stimulations are shown in figure 24b. However, observed overall, it can be said that the change in GSR(skin conductivity) reflects the stress experienced by the volunteers well in comparison to other body changes.

In the calculation test stimulation, the largest change is shown when the stimulation of the first level begins, and increases large proportions again when the difficulty of the level increases at the 18-minute mark which is the response to the second level(4 digits) stimulation. Also, in the case of the CPT, the largest change is shown at the beginning of the stimulation and decreases as time lapses. Therefore, in the case of GSR, with the calculation test as the reference, the 3-minute mark was set as phase 3 and the 18-minute mark was set as phase 2. Phase 1 was set as 50% of phase 2. From the CPT, the first 1-minute was set as phase 3 and values of 50% and 25% of the phase 3 value was set as phase 2 and phase 1, and a summary of the results is shown in table 2. Although these not be variable values found at the same points as the heartbeat number change, it may show different responses form the same stimulations.

It is known that skin temperature decreases under a stressed state, and fact that skin temperature is decreased by stimulation has been confirmed by the present research, and the overall change in the average value is shown in figure 24c. In the case of the calculation test stimulation, since the stimulation is not sudden, skin temperature showed a tendency to slowly decrease as time passed, and in the case of the CPT test stimulation, due to the short data collection time the decreasing tendency was not largely displayed. However, comparing individual volunteers, the variations among individuals were extreme. This is because skin temperature may change according to the temperature of the environment and the sensitivity of the individual's skin temperature change, and the variations between people are very large.

In the case of EEG, as concentration decreased and nervousness increased, among the alpha wave and the beta wave of the brain waves, the alpha wave has decreased in proportion and through this effect, it has been confirmed that mental and physical stress has been applied by the calculation and CPT stimulations, but there has not been a meaningful difference in the change in variables over time.

In the case of respiration, when stimulation is applied to the sympathetic nervous system due to stress or nervousness, the phenomenon of increase in respiration can be seen, and in the present research increase in respiration was observed, but it was difficult to find a meaningful difference in the shape of change.

Through the present research, it has been confirmed that when stress is applied, changes in the variable values of physiological signals are exhibited as the following, and an index to express the level of stress has been found on the bases of heartbeat number and GSR change among the changes.

First, the survey result has been analyzed and whether or not the stimulation methods used in the present research was appropriate to induce stress was observed. Regarding the mental and physical stress question sheet for the calculation test stimulation and CPT stimulation, the level thereof was much more

extreme after the stimulation than before the simulation. That is to say, it has been confirmed that if changes in physiological signals over time can be found, then they may be used as index for the level of stress.

Second, not only is skin temperature variation large for individuals, but it also changes in large proportions according to the temperature of the environment and the sensitivity of the individual's skin temperature change and therefore a reference was comparatively difficult to set, and although it was confirmed that the volunteers were under the state of stress through observation of the alpha wave of the brain and number of breaths taken, there has not been a consistent alteration tendency over time change.

Third, through analysis of the heartbeat number and GSR, the stress index value was able to be found for the calculation test stimulation and CPT stimulation, and when the level of stress is classified into three phases, the physiological signal variable representing respective phases may be calculated into a percent change rate against a reference value through equation 5.

【Equation 5】

$$Stress\ Level1 : HR = 1.03 \times HR_{ref} \ \ or \ \ GSR = 1.27 \times GSR_{ref}$$
$$Stress\ Level2 : HR = 1.05 \times HR_{ref} \ \ or \ \ GSR = 1.54 \times GSR_{ref}$$
$$Stress\ Level3 : HR = 1.09 \times HR_{ref} \ \ or \ \ GSR = 1.83 \times GSR_{ref}$$

Wherein, HR has set the calculation test stimulation as reference and GSR was found with the average of the index values obtained through the calculation and CPT stimulation. Also, ref is the initial value before the volunteers entered the stimulation state, and has significant difference in the absolute value for individuals and therefore was used to set the reference value for individuals and measure the change from that value.

【Table 1】

	Step 1	Step 2	Step 3
Cacularion Test Stimulation	102.43%	104.86%	109.72%
CPT Stimulation	101.96%	103.92%	107.84%

【Table 2】

	Step 1	Step 2	Step 3
Cacularion Test Stimulation	132%	164%	178%
CPT Stimulation	122%	144%	188%

【Industrial Usage】

As described heretofore, according to the automatic stress recognition peripheral device and the stress measurement system using a computer of the present invention, by inserting a simple circuit in an existing peripheral device, the peripheral device may automatically measure various body information and check the level of stress or fatigue and thereby is able to provide data of which the computer user may use to relieve or resolve stress.

CLAIMS

【Claim 1】

A stress measurement system using a computer comprising:

a computer peripheral device(300) including a body information measuring section which measures body information of the computer user, a means(400) for signal processing said measured body information, and a means(800) for transmitting said signal processed body information signal to the computer main body; and

a computer main body(200) provided with a stress recognition program which computes body information change coefficients from said transmitted body information signal and computes stress indexes by setting weighted values on respective said coefficients and calculation.

【Claim 2】

The stress measurement system of claim 1, wherein said body information measuring section includes at least a skin conductivity measuring section and a pulse measuring section.

【Claim 3】

The stress measurement system of claim 2, wherein said body information measuring section further includes a body temperature measuring section and a muscle conductivity measuring section.

【Claim 4】

The stress measurement system of claim 1, wherein said signal processing means includes a means(420) for A/D converting the detected body signal, a means(430) for temporarily storing the detected body signal information, and a controller(410).

【Claim 5】

The stress measurement system of claim 1, wherein said stress recognition program further includes a stress index indication section which allows display of computed the stress indexes.

【Claim 6】

The stress measurement system of claim 1, wherein

said computer main body includes a stress recognition program processor(260) besides a windows program processor(250) which processes general computer input/output, and said computer main body is further provided with a device driver(240) for switching input data to the stress recognition program processor(260) in case the input data is body information data, when data is inputted from the peripheral device.

【Claim 7】

The stress measurement system of claim 1, wherein said computer peripheral device is a mouse for computer use.

【Claim 8】

A computer peripheral device(300) comprising:

a body information measuring section for measuring body information of a computer user, a means(400) for signal processing said measured body information, and a means(800) for transmitting said signal processed body information signal to the computer main body, wherein

said body information measuring section includes a skin conductivity measuring section(500; 500') and a pulse measuring section(700; 700'),

said skin conductivity measuring section includes a first electrode(501) for authorizing testing signals to the skin, a second electrode(502) for sensing body information signals from the skin, and an output(570; 570') for outputting the signal sensed from the second electrode to the signal processor(400),

said pulse measuring section includes a light emitter and receiver(710), a amplification section for amplifying and outputting detected signals to the signal processor, and a comparison section(790) which compares said amplified signal with a reference voltage(Vref) and digitalizes the signal for the counting thereof.

【Claim 9】

The computer peripheral device of claim 8, wherein said computer

peripheral device has a point function which is a X-Y axis direction movement detection means.

FIG. 1

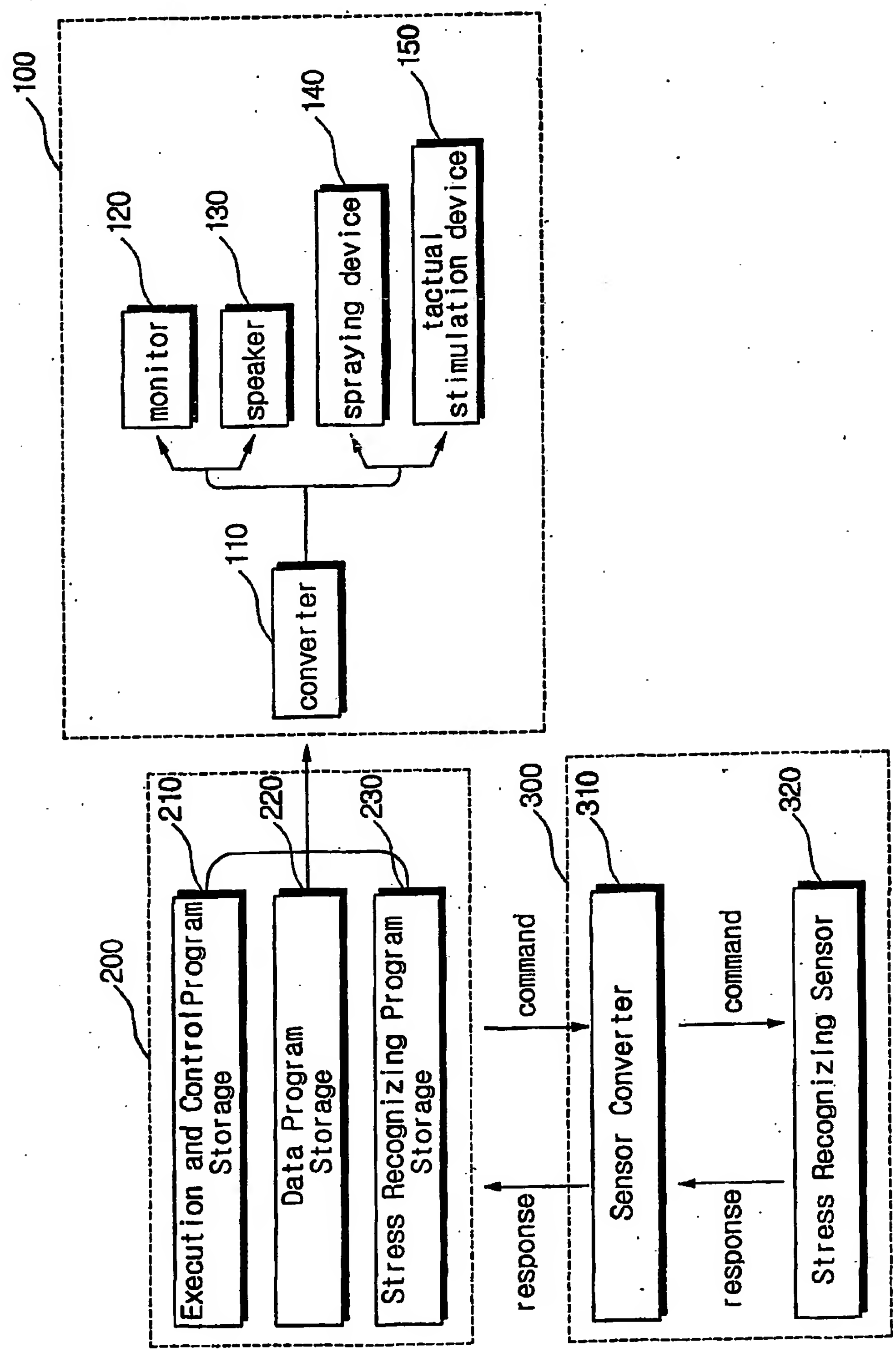

100
110
converter
120
monitor
130
speaker
140
spraying device
150
tactual stimulation device
200
210
Execution and Control Program Storage
220
Data Program Storage
230
Stress Recognizing Program Storage
command
response
300
310
Sensor Converter
command
response
320
Stress Recognizing Sensor

FIG. 2

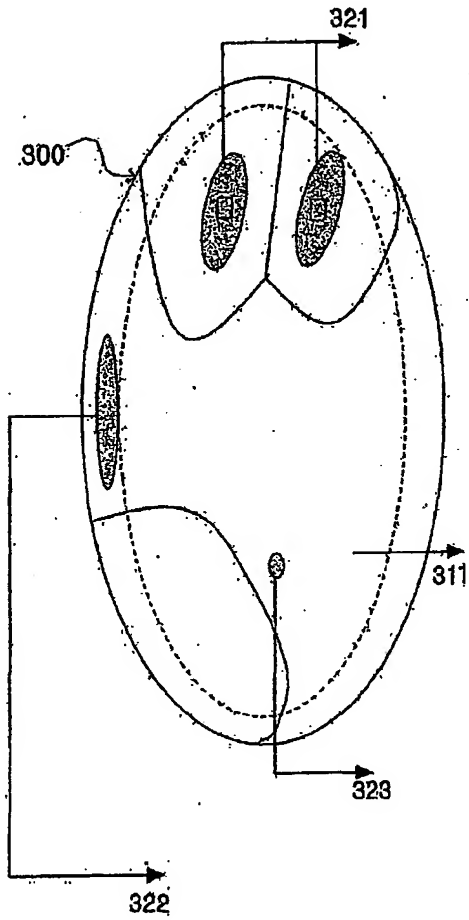


FIG. 3

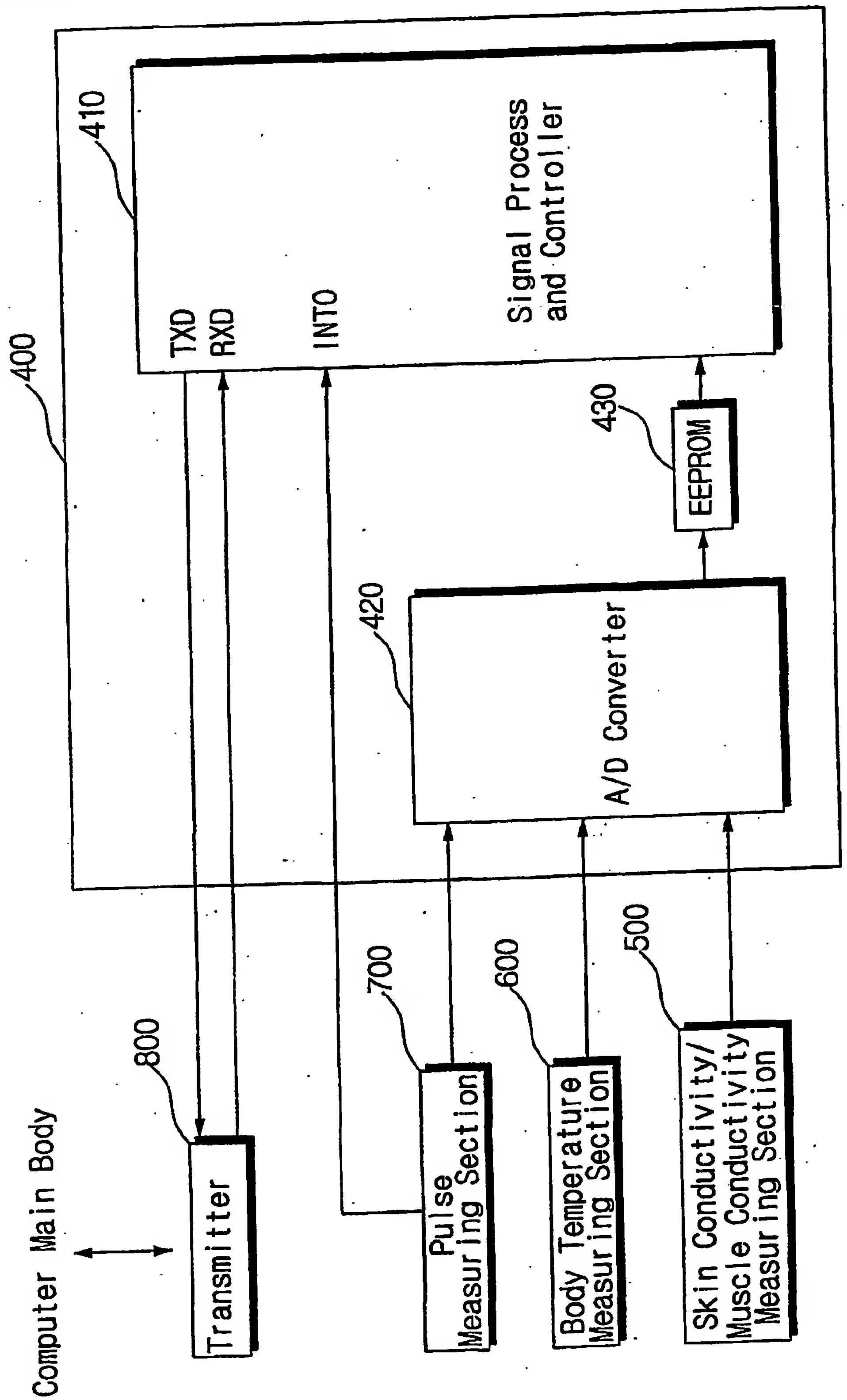

Signal Process
and Controller
410
TXD
RXD
INTO
400
430
EEPROM
420
A/D Converter
700
600
500
800
Computer Main Body
Transmitter
Pulse
Measuring Section
Body Temperature
Measuring Section
Skin Conductivity/
Muscle Conductivity
Measuring Section

FIG. 4

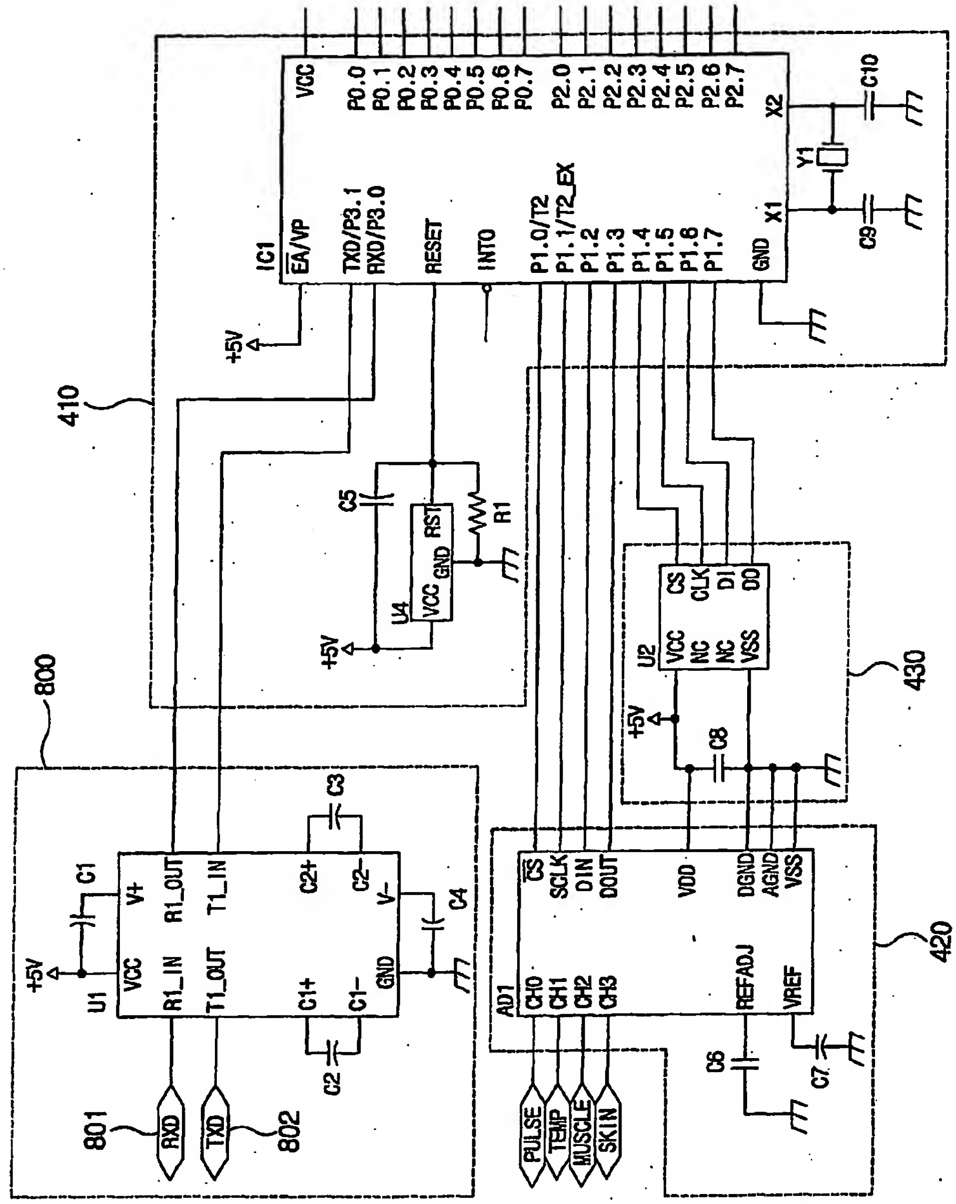

IC1
VCC
P0.0
P0.1
P0.2
P0.3
P0.4
P0.5
P0.6
P0.7
P2.0
P2.1
P2.2
P2.3
P2.4
P2.5
P2.6
P2.7
X2
X1
Y1
C10
C9
EA/VP
TXD/P3.1
RXD/P3.0
RESET
INT0
P1.0/T2
P1.1/T2_EX
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
GND
+5V
410
C5
RST
GND
VCC
U4
R1
CS
CLK
DI
DO
U2
VCC
NC
NC
VSS
C8
430
800
U1
VCC
V+
R1_OUT
T1_IN
C2+
C2-
V-
R1_IN
T1_OUT
C1+
C1-
GND
C1
C2
C3
C4
RXD
TXD
801
802
CS
SCLK
DIN
DOUT
VDD
DGND
AGND
VSS
AD1
CH0
CH1
CH2
CH3
REFADJ
VREF
C6
C7
420
PULSE
TEMP
MUSCLE
SKIN

FIG. 5a

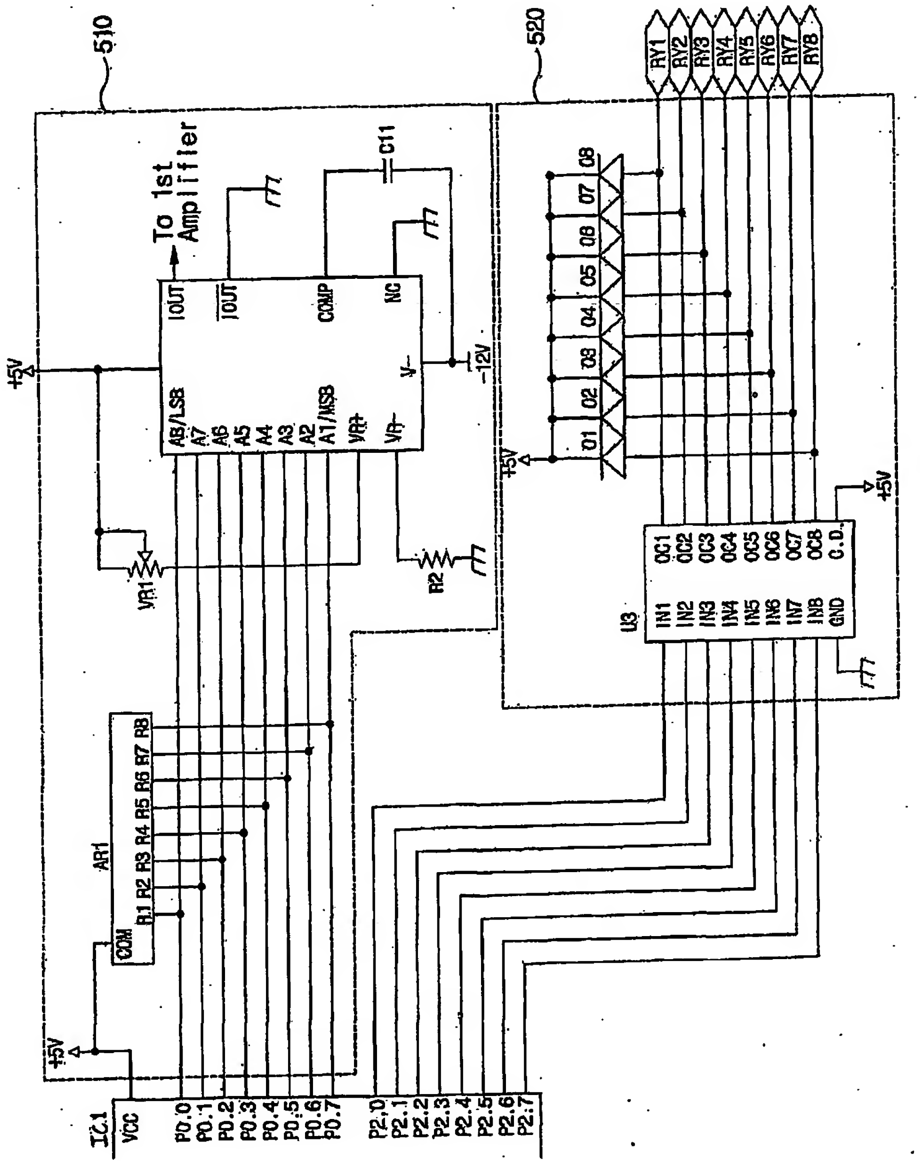

510
520
To 1st Amplifier
IOUT
$\overline{IOUT}$
COMP
NC
C11
-12V
+5V
A8/LSB
A7
A6
A5
A4
A3
A2
A1/MSB
VR+
VR-
V-
VR1
R2
AR1
COM
R1 R2 R3 R4 R5 R6 R7 R8
RY1 RY2 RY3 RY4 RY5 RY6 RY7 RY8
D1 D2 D3 D4 D5 D6 D7 D8
U3
IN1 IN2 IN3 IN4 IN5 IN6 IN7 IN8 GND
OC1 OC2 OC3 OC4 OC5 OC6 OC7 OC8 C.D.
IC1
VCC
P0.0 P0.1 P0.2 P0.3 P0.4 P0.5 P0.6 P0.7
P2.0 P2.1 P2.2 P2.3 P2.4 P2.5 P2.6 P2.7

FIG. 5b

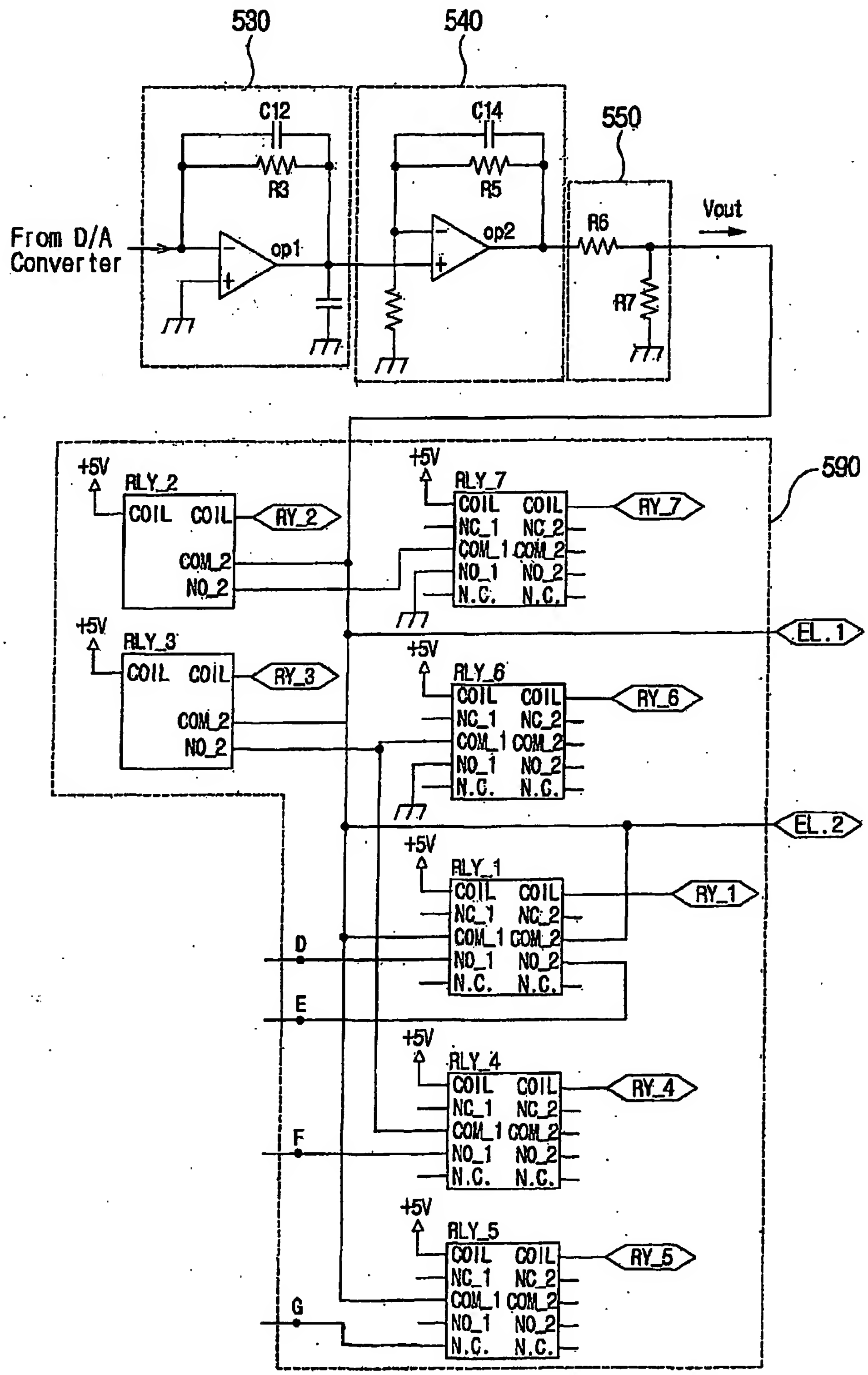

530
540
550
590
C12
R3
C14
R5
From D/A Converter
op1
op2
R6
R7
Vout
+5V
RLY_2
COIL COIL
COM_2
NO_2
RY_2
RLY_3
RY_3
RLY_7
RY_7
RLY_6
RY_6
RLY_1
RY_1
RLY_4
RY_4
RLY_5
RY_5
NC_1 NC_2
COM_1 COM_2
NO_1 NO_2
N.C. N.C.
EL.1
EL.2
D
E
F
G

FIG. 5c

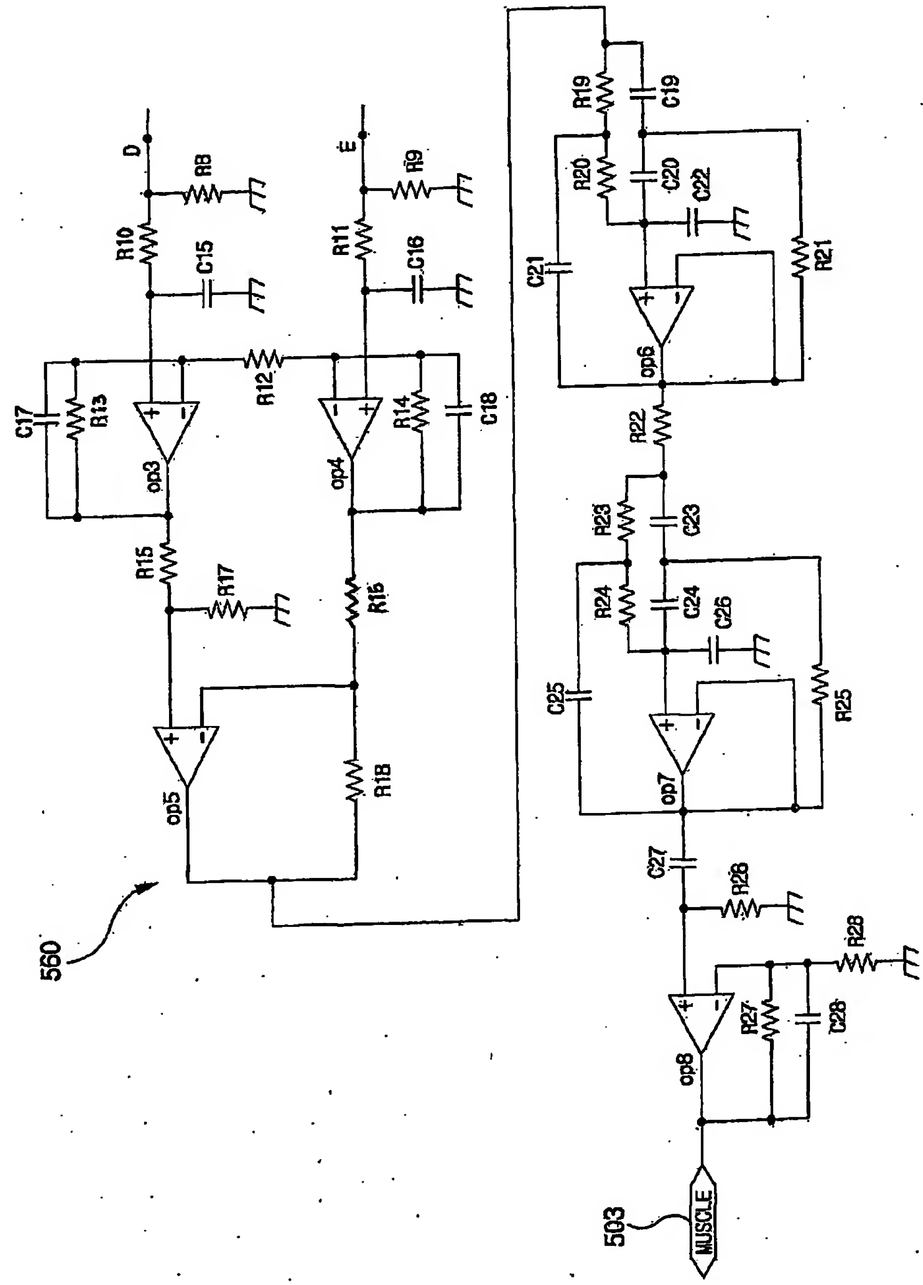

D
E
R8
R9
R10
R11
C15
C16
R12
C17
R13
R14
C18
op3
op4
R15
R16
R17
R18
op5
560
R19
C19
R20
C20
C22
C21
R21
op6
R22
R23
C23
R24
C24
C26
C25
R25
op7
C27
R26
R28
R27
C28
op8
503
MUSCLE

FIG. 5d

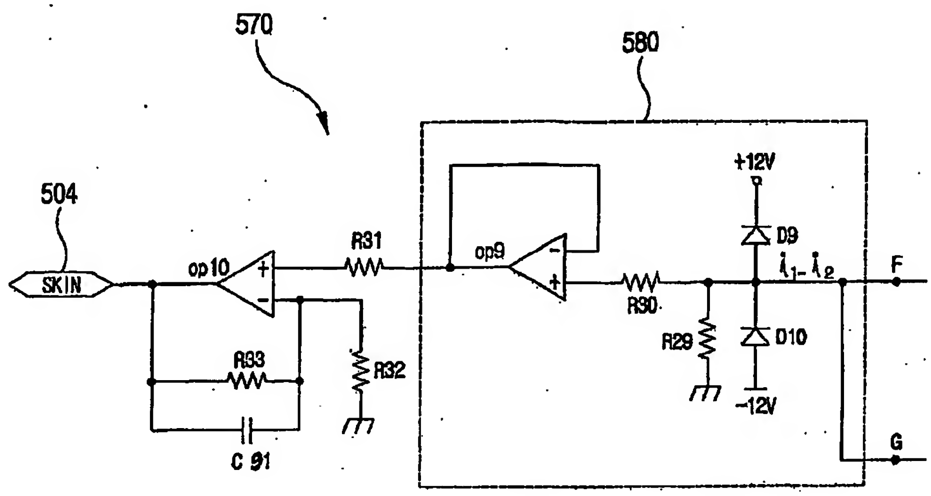

570
580
504
SKIN
op10
R31
op9
+12V
D9
i_1- i_2
F
R30
R29
D10
-12V
R33
R32
C 91
G

FIG. 5e

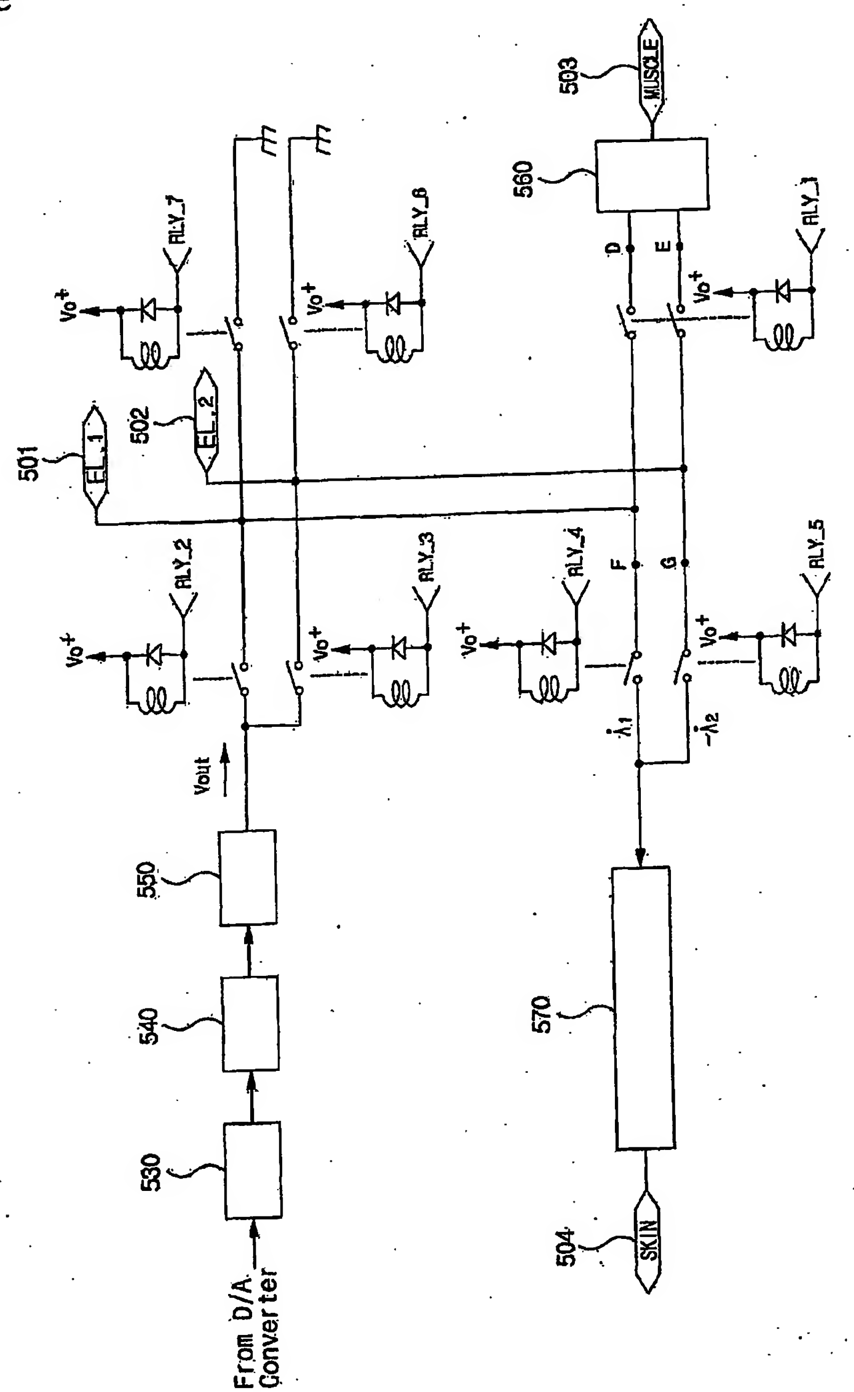

From D/A Converter
530
540
550
Vout
RLY_2
RLY_3
RLY_7
RLY_8
RLY_4
RLY_5
RLY_1
Vo+
501
EL_1
502
EL_2
503
MUSCLE
504
SKIN
560
570
D
E
F
G

FIG. 6

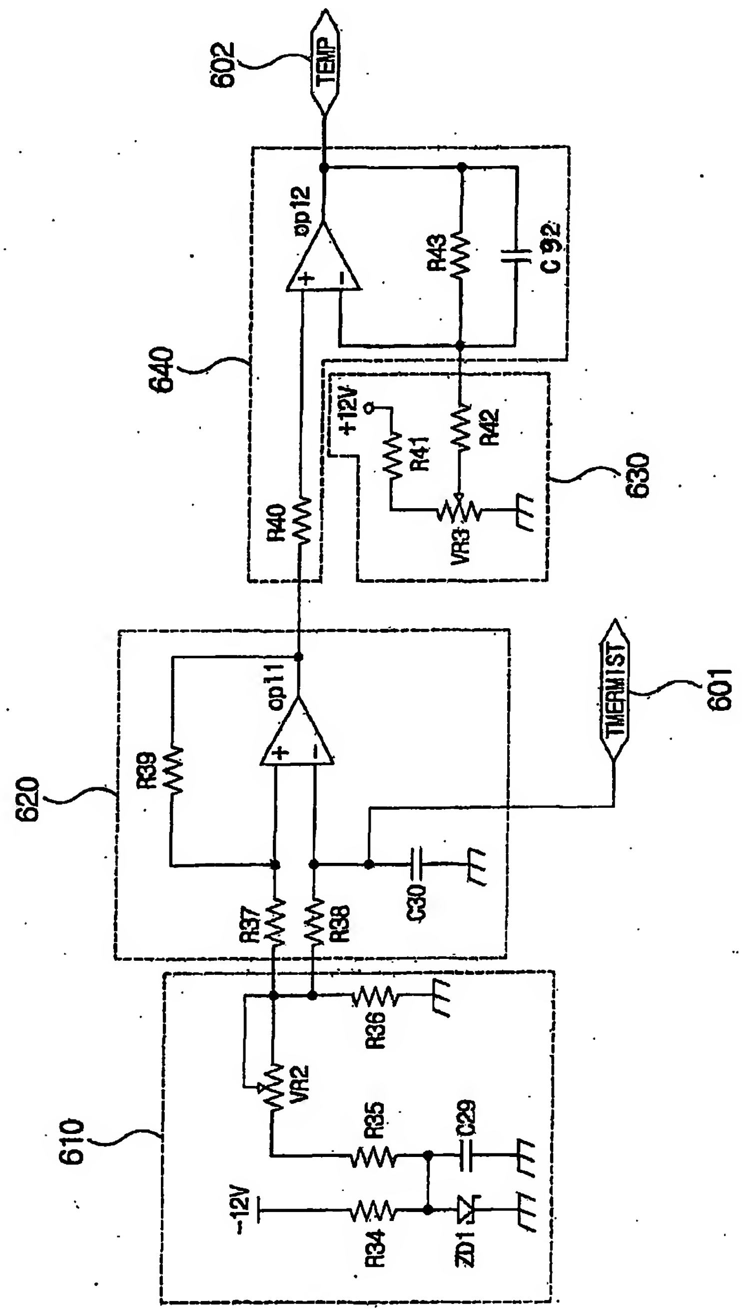

602
TEMP
640
op12
R43
C32
R42
R41
+12V
VR3
630
R40
op11
R39
620
TMERMIST
601
R37
R38
C30
R36
VR2
610
R35
C29
-12V
R34
ZD1

FIG. 7a

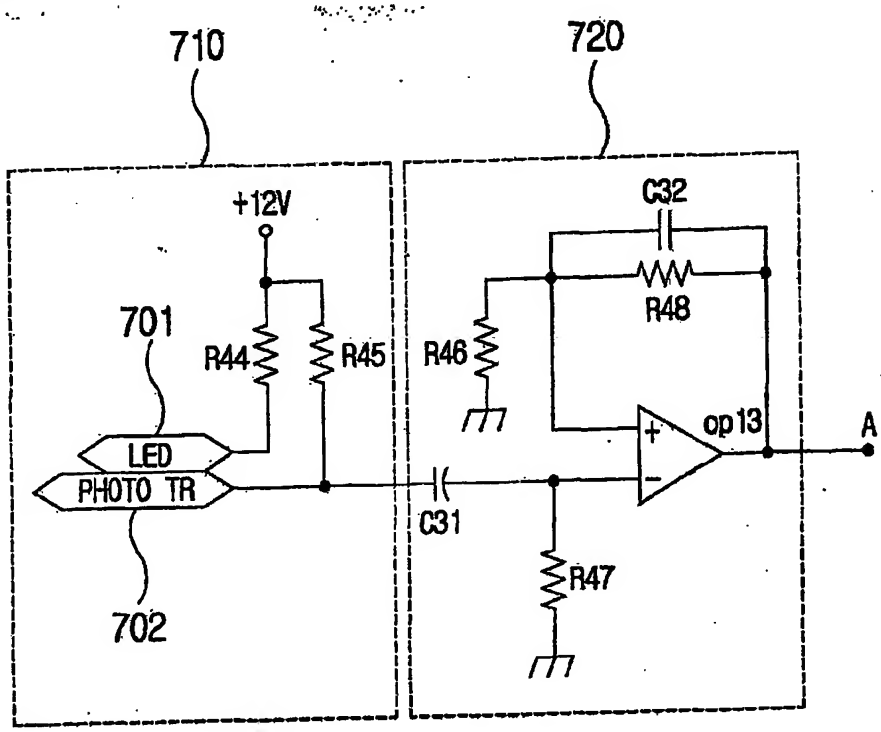

710
720
+12V
C32
R48
701
R44
R45
R46
LED
PHOTO TR
op13
A
C31
R47
702

FIG. 7b

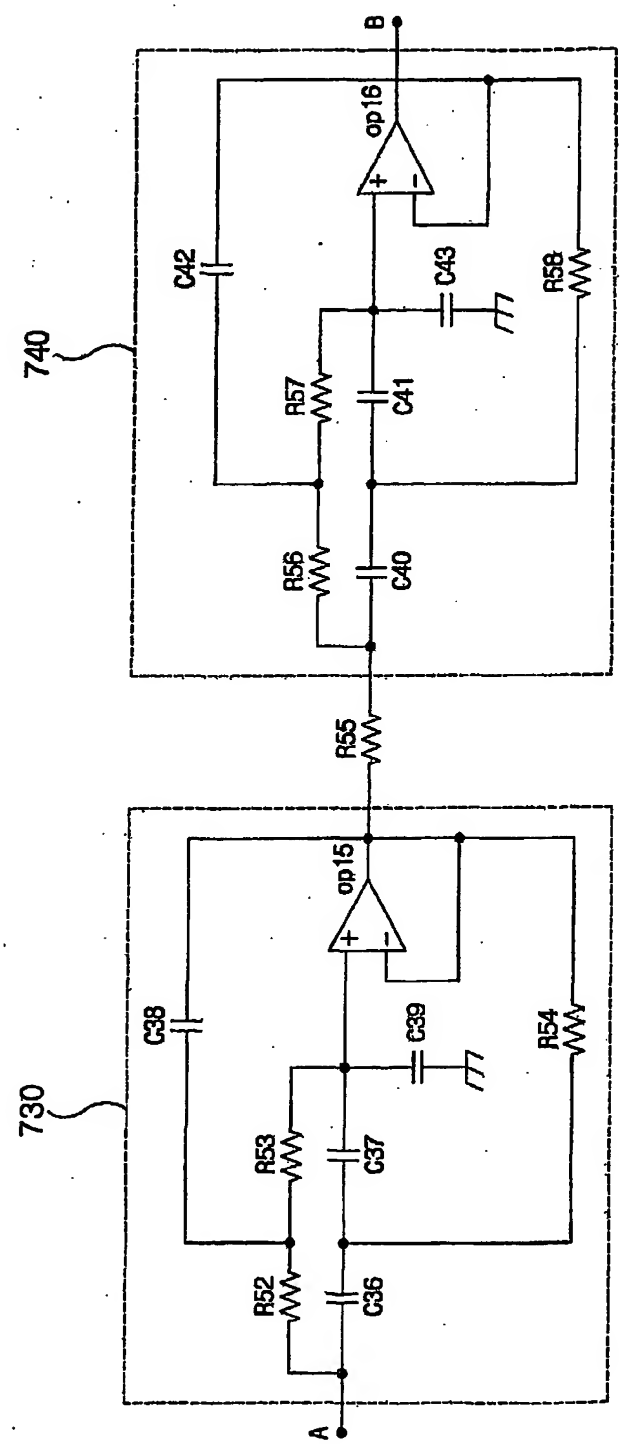

B
op16
C42
C43
R58
740
R57
C41
R56
C40
R55
op15
C38
C39
R54
730
R53
C37
R52
C36
A

FIG. 7c

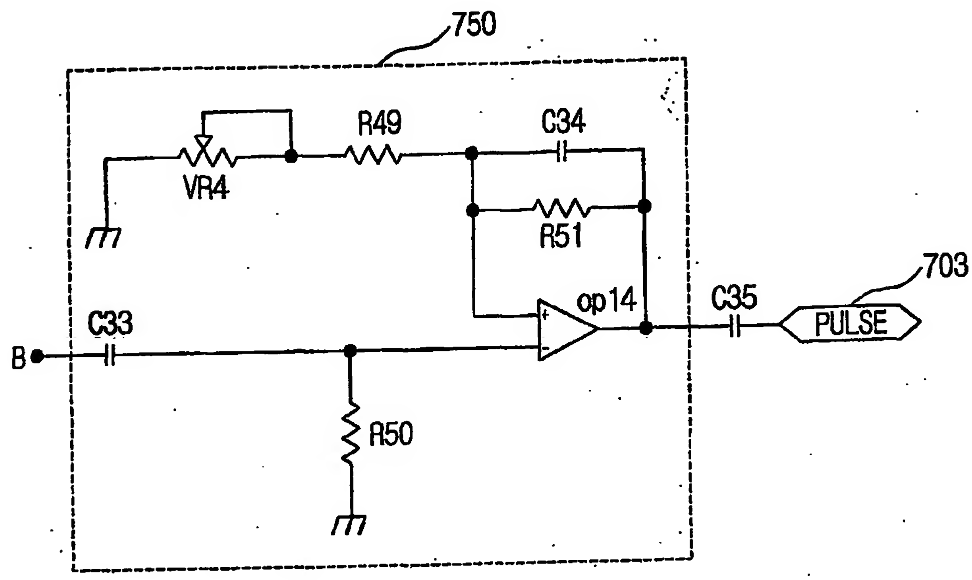


FIG. 7d

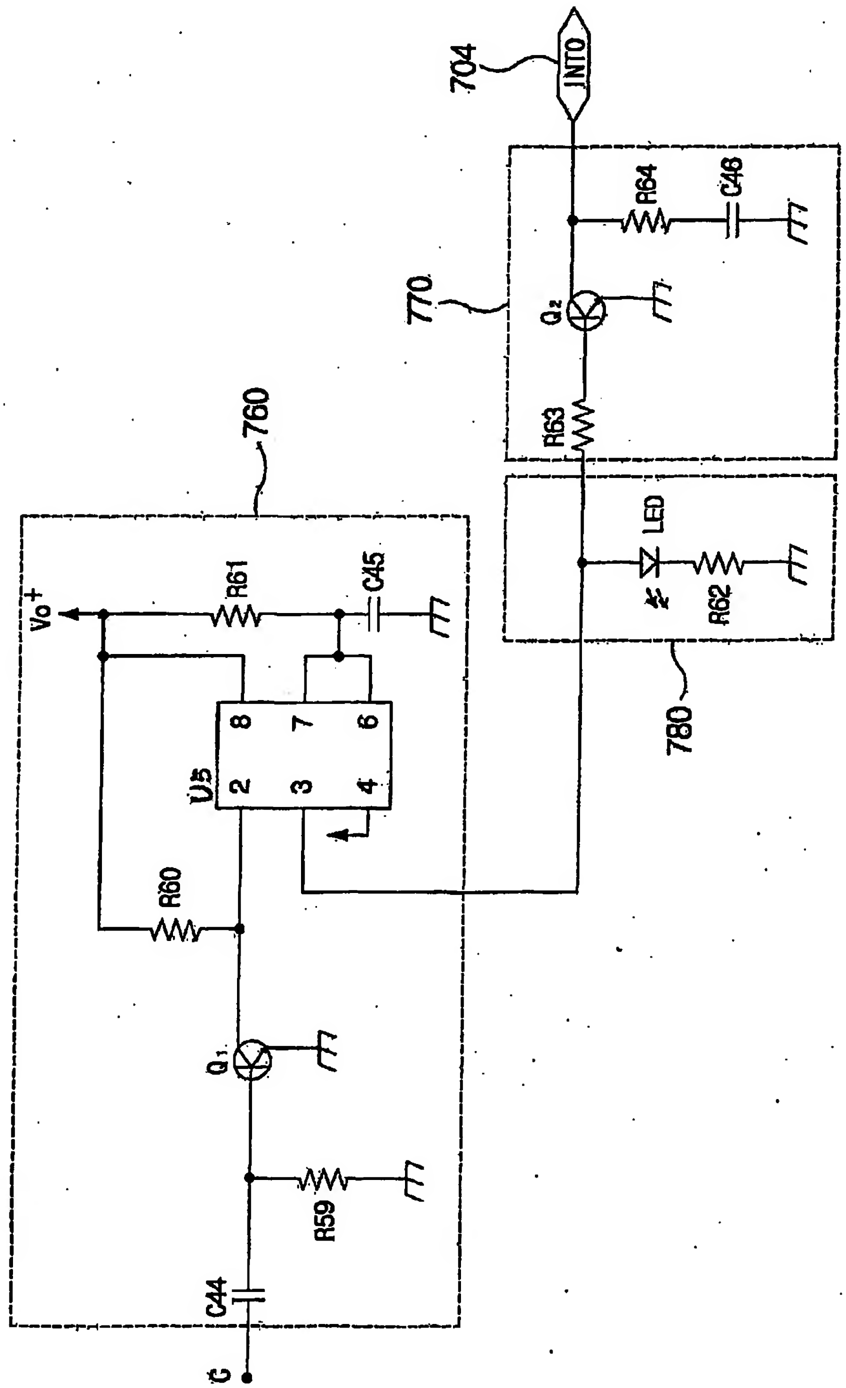

704
INT0
R64
C46
770
Q2
R63
760
LED
R62
780
Vo+
R61
C45
U5
8
7
6
2
3
4
R60
Q1
R59
C44
G

FIG. 8

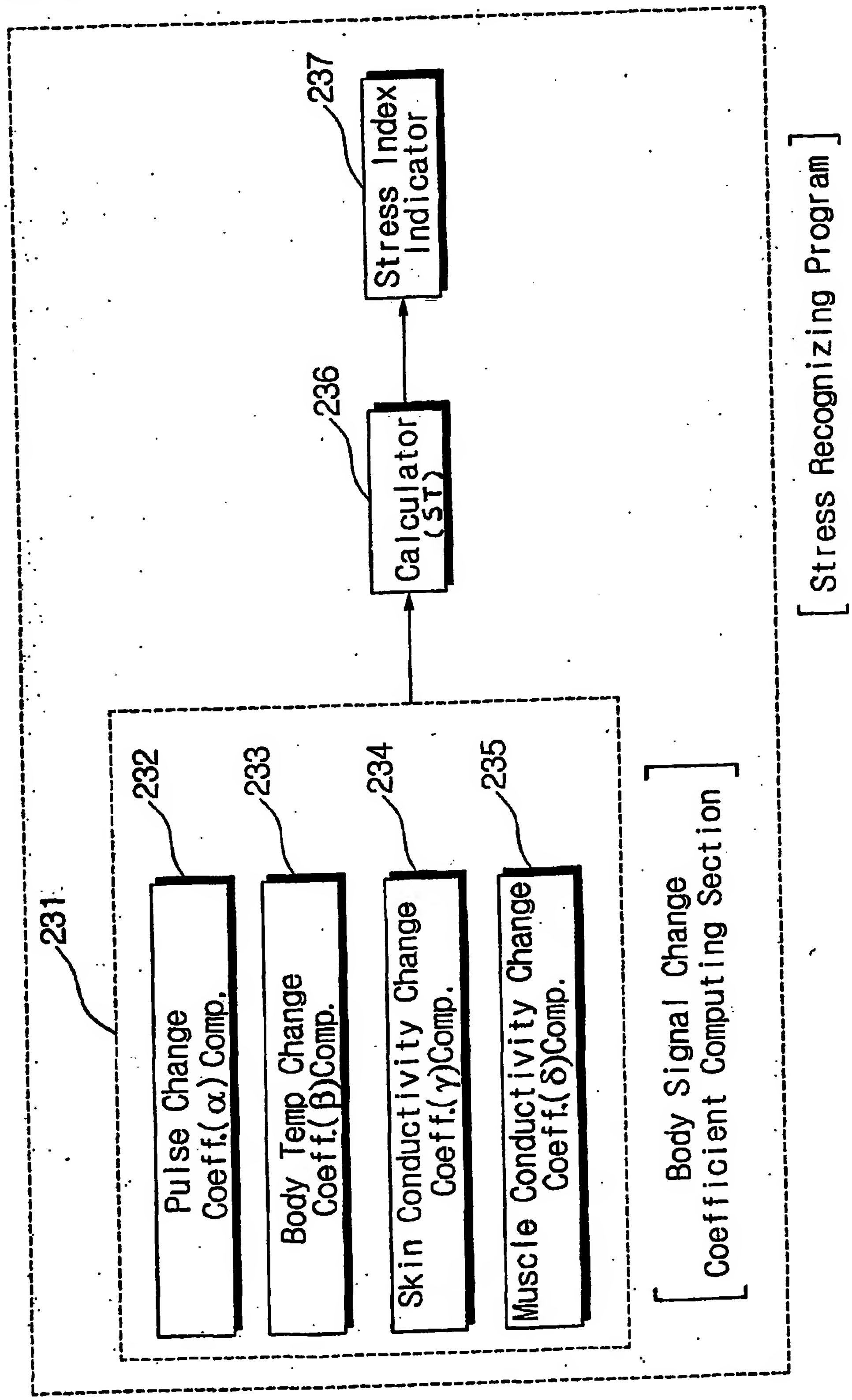

237
Stress Index Indicator
236
Calculator (ST)
Stress Recognizing Program
231
232
Pulse Change Coeff.(α) Comp.
233
Body Temp Change Coeff.(β)Comp.
234
Skin Conductivity Change Coeff.(γ)Comp.
235
Muscle Conductivity Change Coeff.(δ)Comp.
Body Signal Change Coefficient Computing Section

FIG. 9

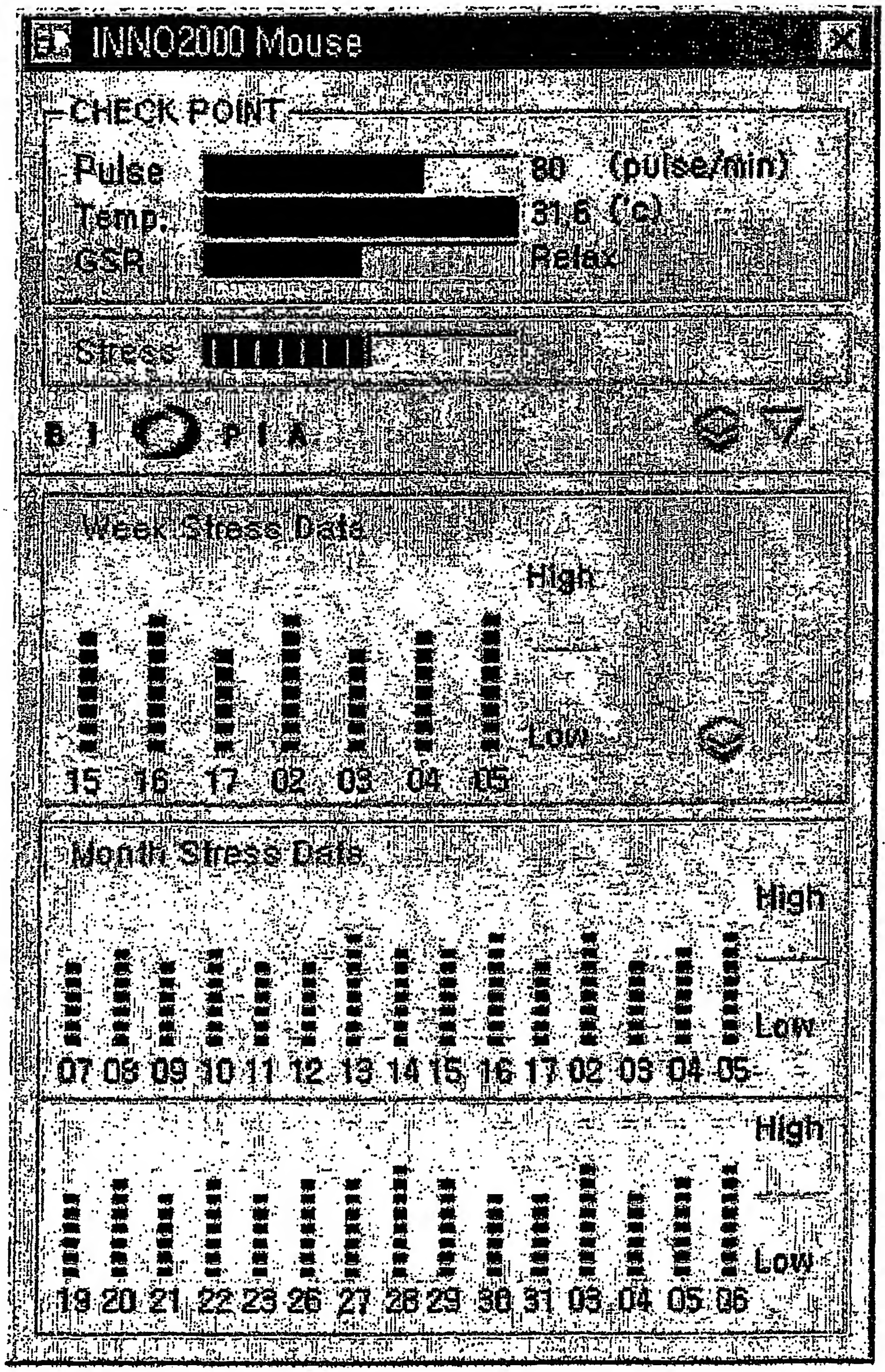

INNO2000 Mouse
CHECK POINT
Pulse
80 (pulse/min)
Temp.
31.6 (c)
GSR
Relax
Stress
Week Stress Data
High
Low
15 16 17 02 03 04 05
Month Stress Data
High
Low
07 08 09 10 11 12 13 14 15 16 17 02 03 04 05
High
Low
19 20 21 22 23 26 27 28 29 30 31 03 04 05 06

FIG. 10

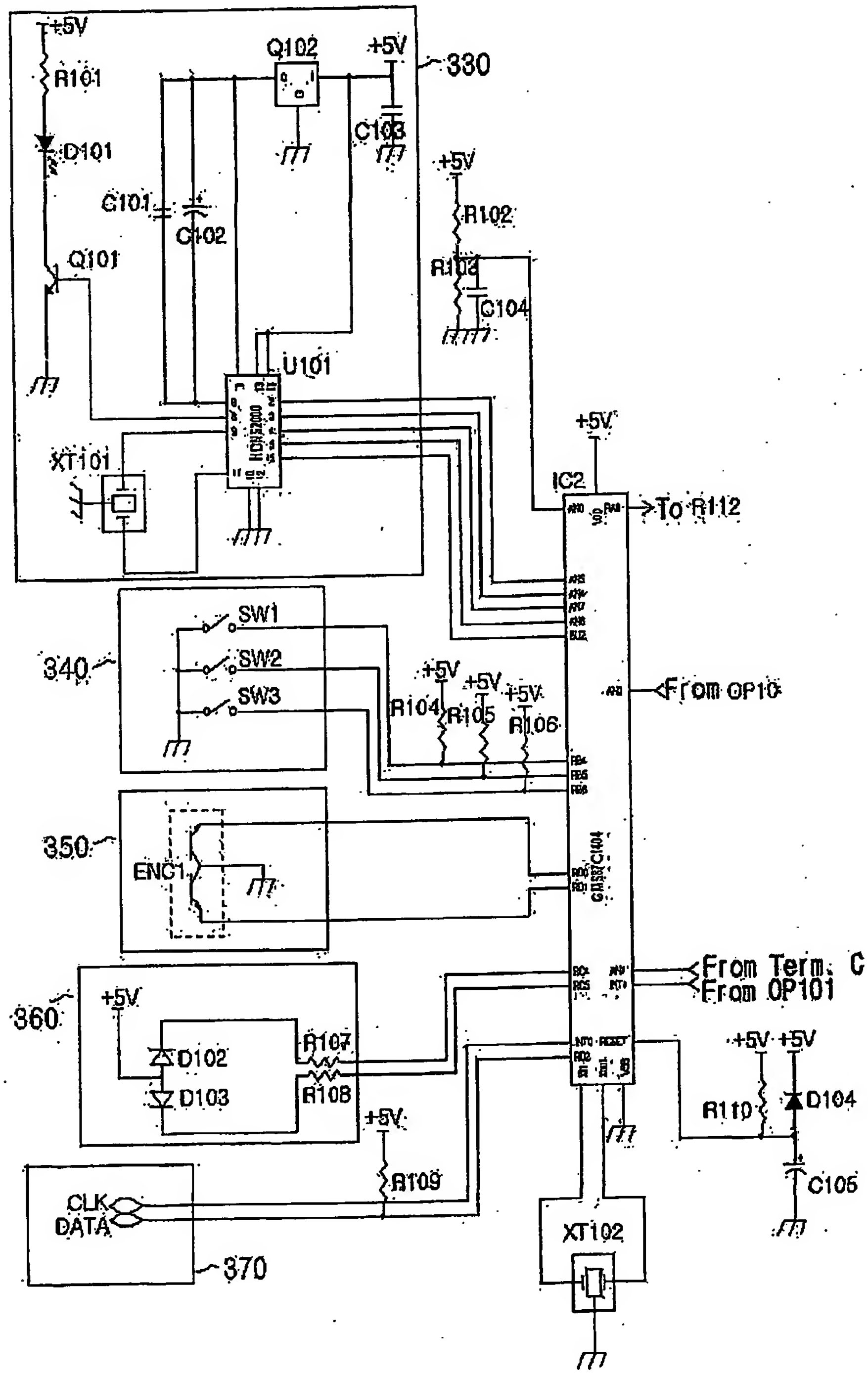

+5V
R101
D101
Q102
+5V
330
C103
C101
C102
Q101
+5V
R102
R103
C104
U101
+5V
XT101
IC2
To R112
SW1
340
SW2
SW3
+5V
+5V
+5V
R104
R105
R106
From OP10
350
ENC1
From Term. C
From OP101
360
+5V
D102
D103
R107
R108
+5V
+5V
R110
D104
+5V
R109
C105
CLK
DATA
XT102
370

FIG. 11

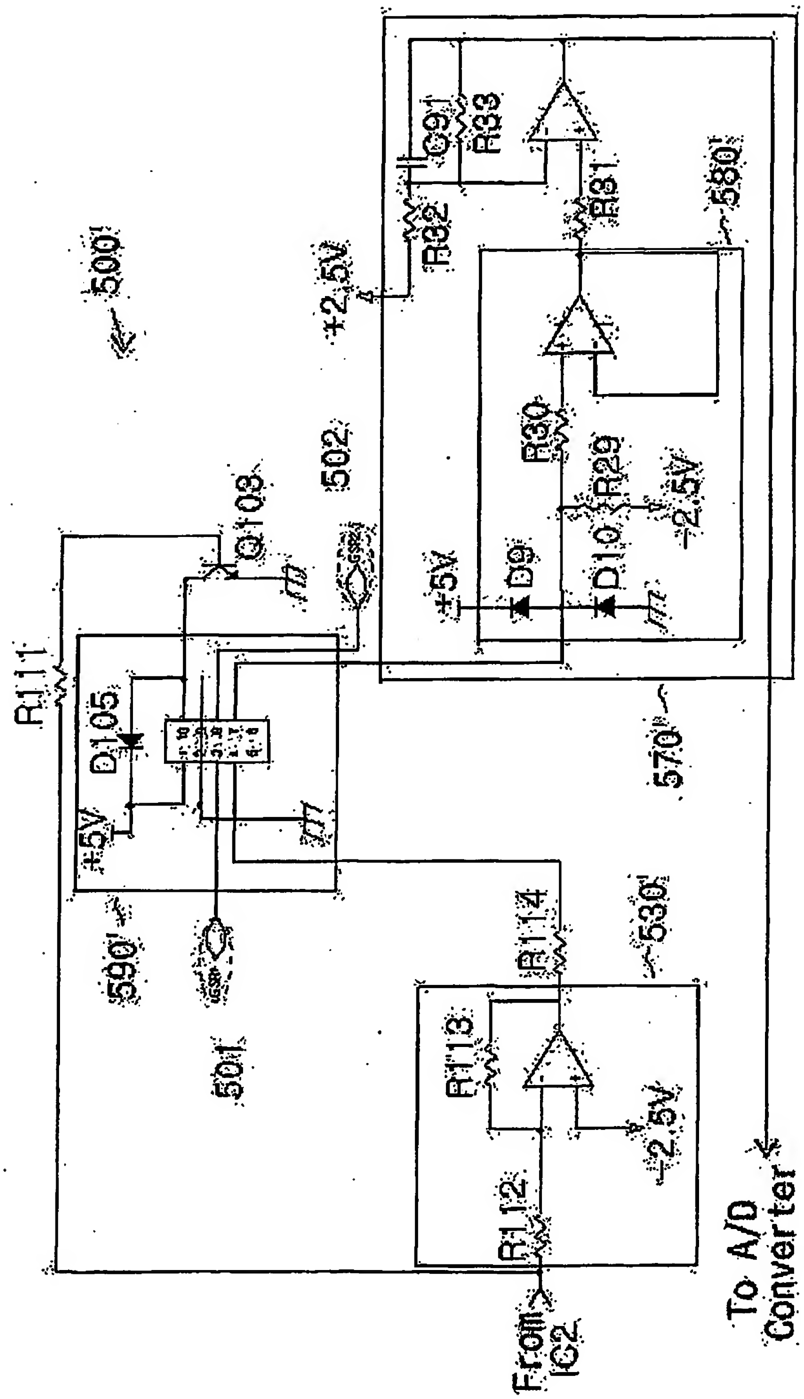

500
502
R111
D105
+5V
Q103
+2.5V
R32
C91
R33
R31
580
R30
R29
-2.5V
+5V
D9
D10
570
590
530
R114
R113
R112
-2.5V
501
From IC2
To A/D Converter

FIG. 12

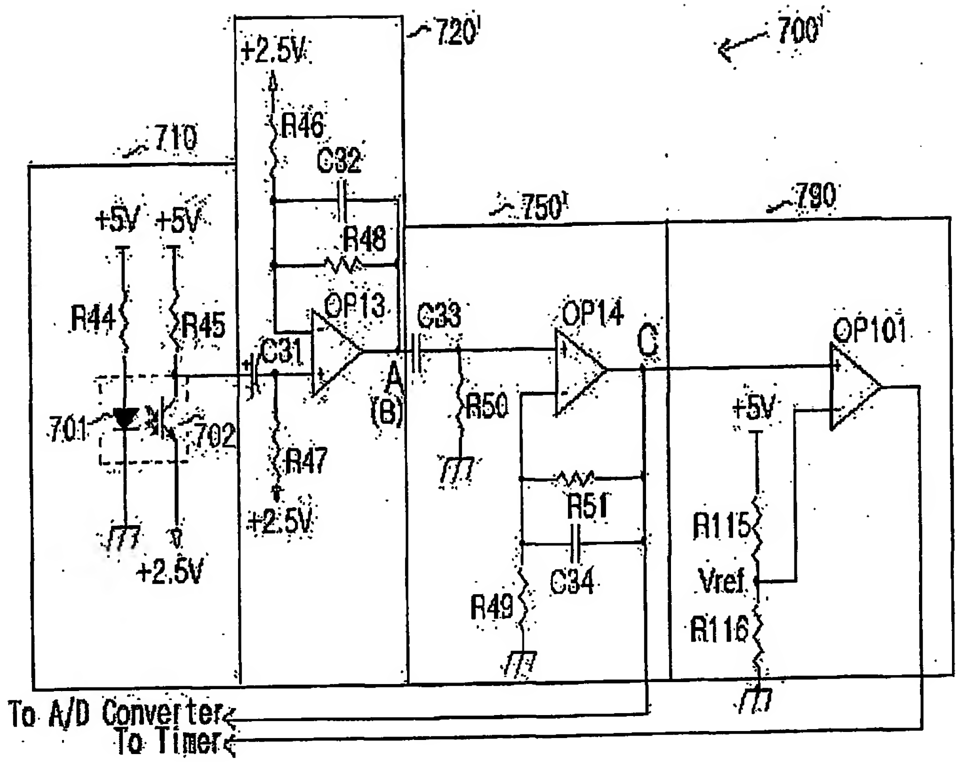

720'
700'
+2.5V
R46
C32
710
R48
+5V +5V
750'
790
R44
R45
OP13
C33
OP14
C
OP101
C31
A
(B)
R50
+5V
701
702
R47
R51
+2.5V
R115
+2.5V
Vref
R49
C34
R116
To A/D Converter
To Timer

FIG. 13

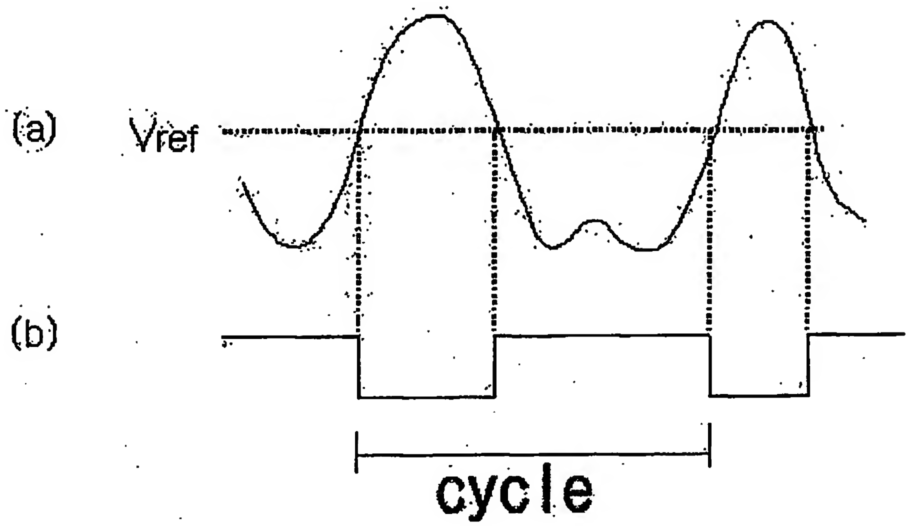

(a)
Vref
(b)
cycle

FIG. 14

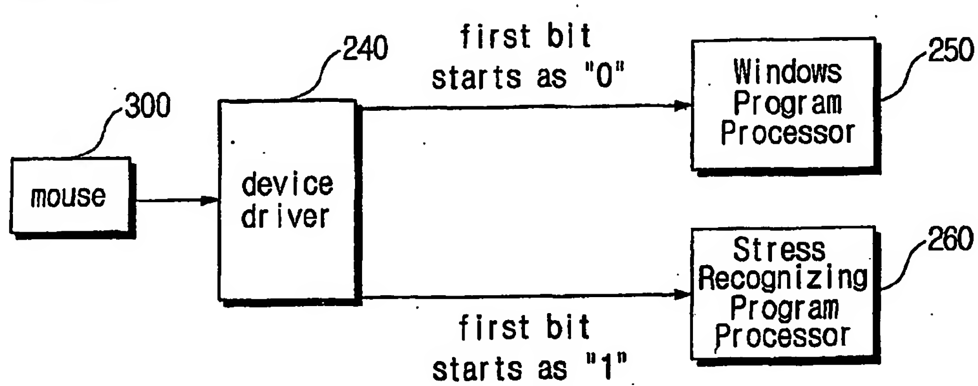

300
mouse
240
device driver
first bit starts as "0"
first bit starts as "1"
Windows Program Processor
250
Stress Recognizing Program Processor
260

FIG. 15a

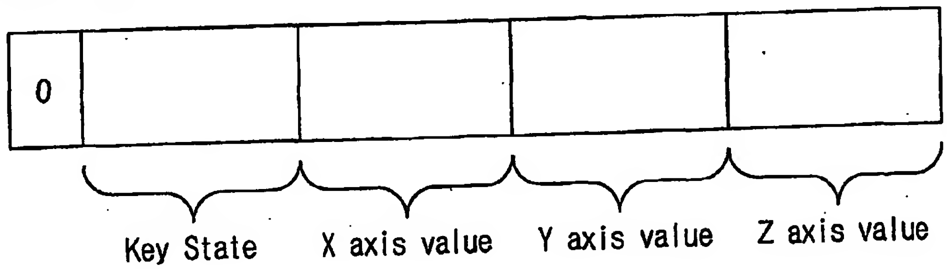


FIG. 15b

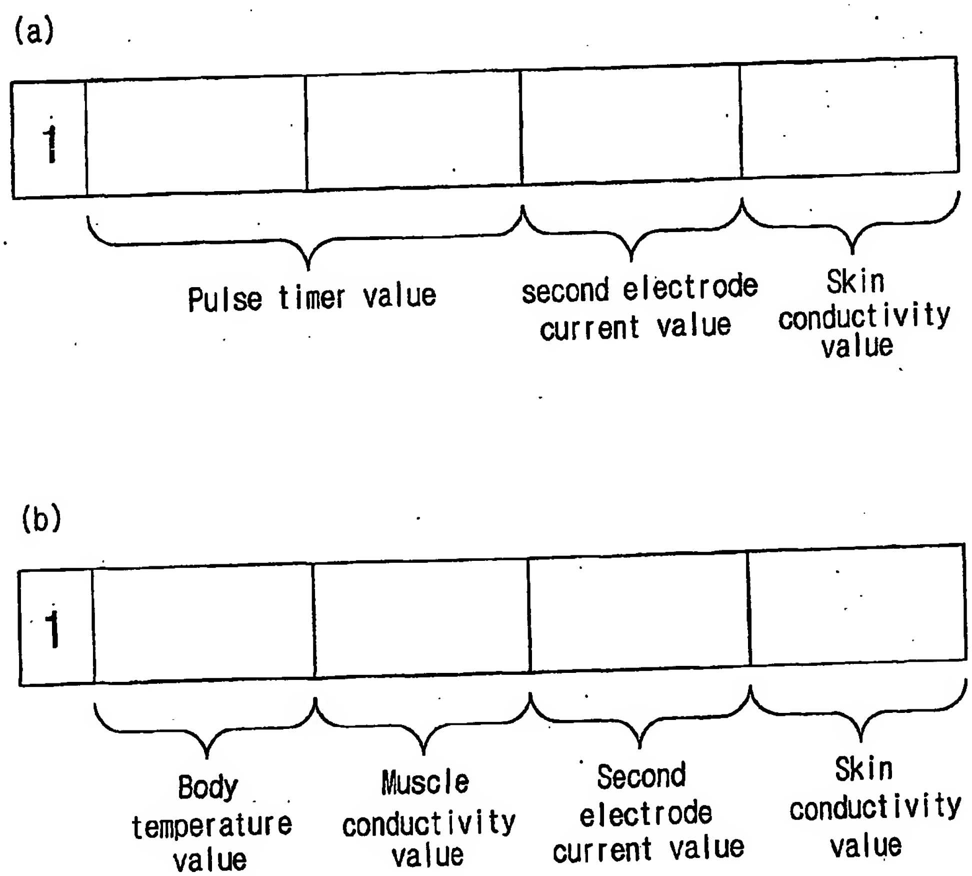


FIG. 16

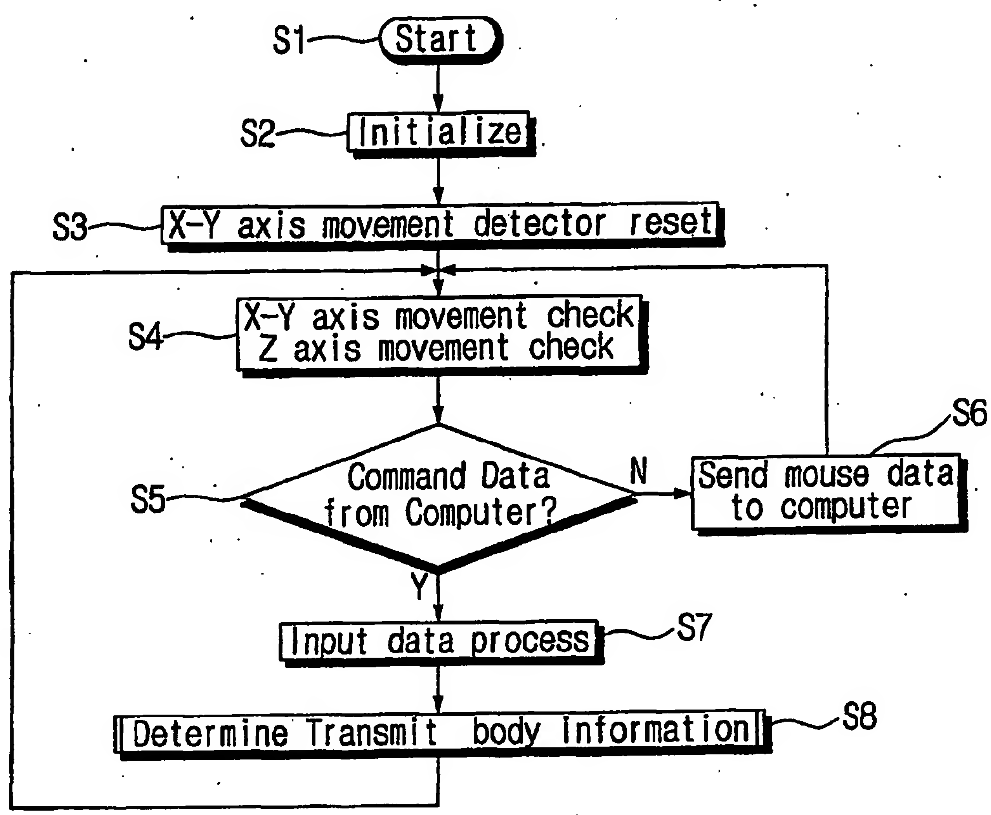

S1
Start
S2
Initialize
S3
X-Y axis movement detector reset
S4
X-Y axis movement check
Z axis movement check
S5
Command Data
from Computer?
N
S6
Send mouse data
to computer
Y
Input data process
S7
Determine Transmit body information
S8

FIG. 17

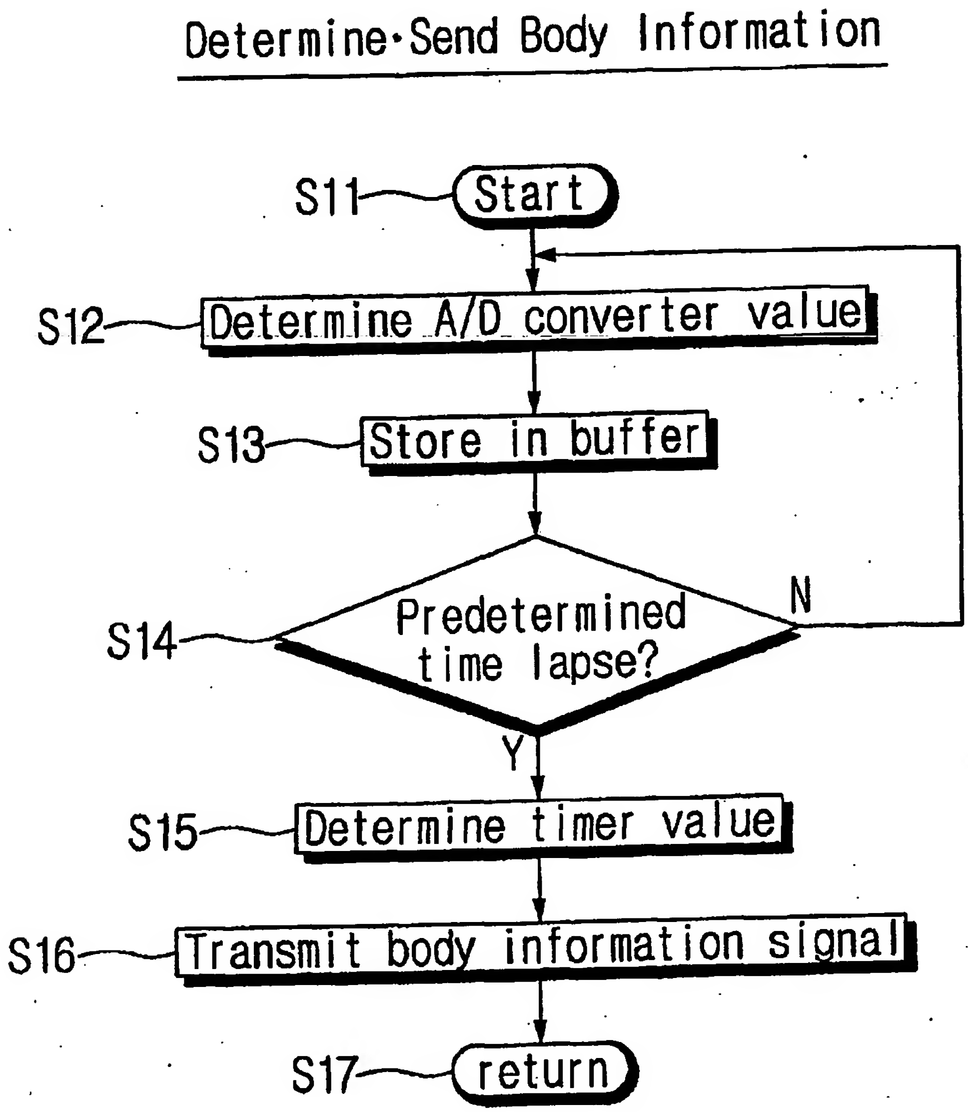

Determine·Send Body Information
S11
Start
S12
Determine A/D converter value
S13
Store in buffer
S14
Predetermined time lapse?
N
Y
S15
Determine timer value
S16
Transmit body information signal
S17
return

FIG. 18

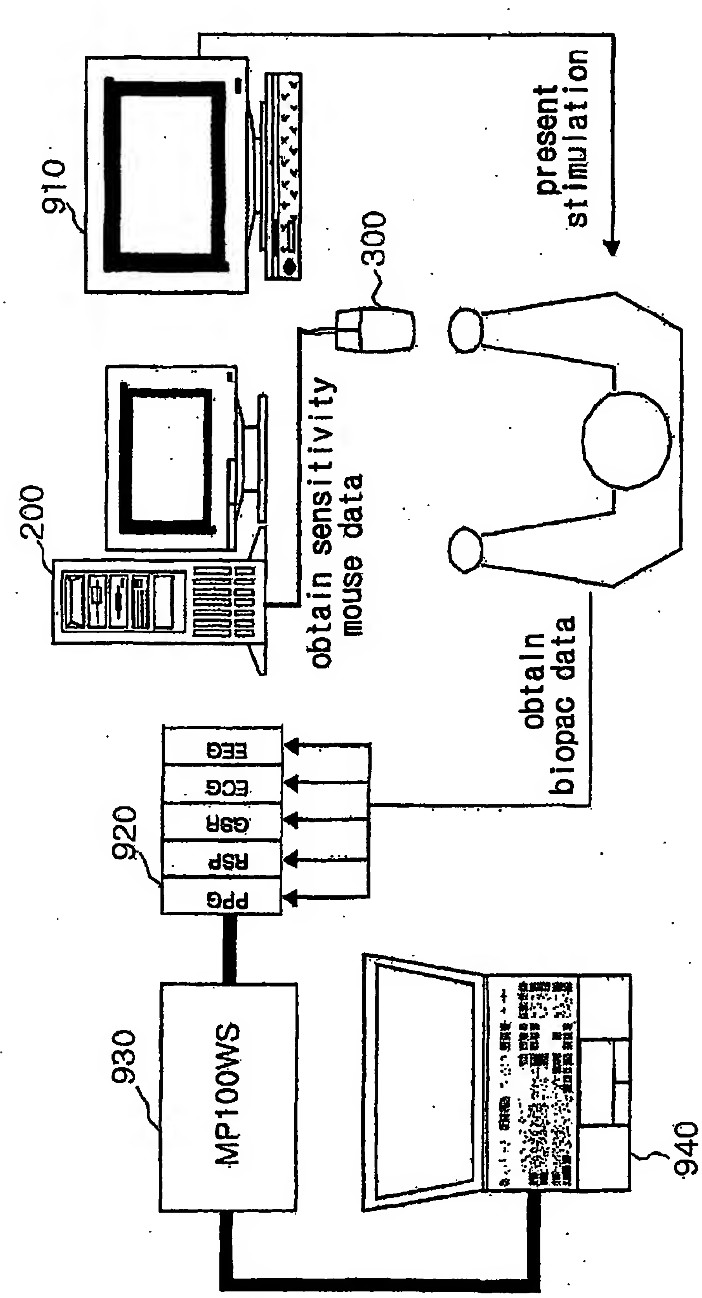

910
present stimulation
300
200
obtain sensitivity mouse data
obtain biopac data
EEG
ECG
GSR
RSP
PPG
920
930
MP100WS
940

FIG. 19

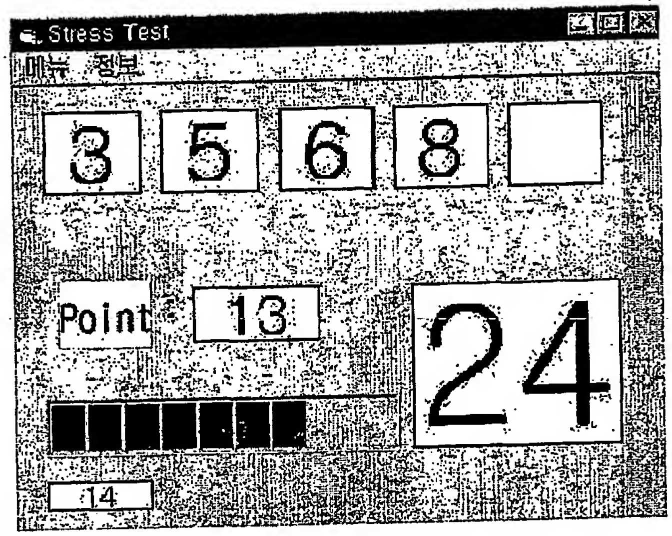


FIG. 20a

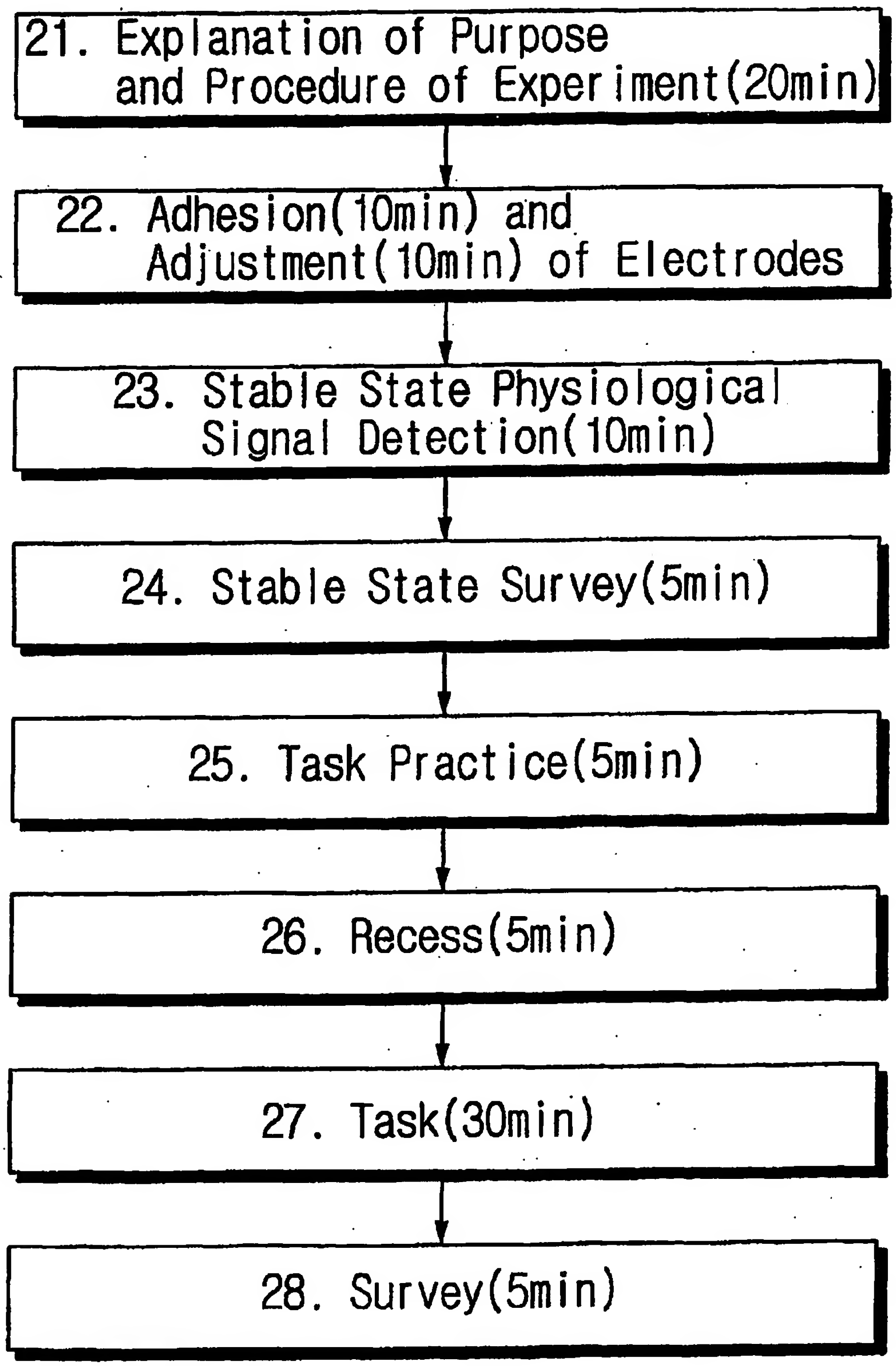

21. Explanation of Purpose and Procedure of Experiment(20min)
22. Adhesion(10min) and Adjustment(10min) of Electrodes
23. Stable State Physiological Signal Detection(10min)
24. Stable State Survey(5min)
25. Task Practice(5min)
26. Recess(5min)
27. Task(30min)
28. Survey(5min)

FIG. 20b

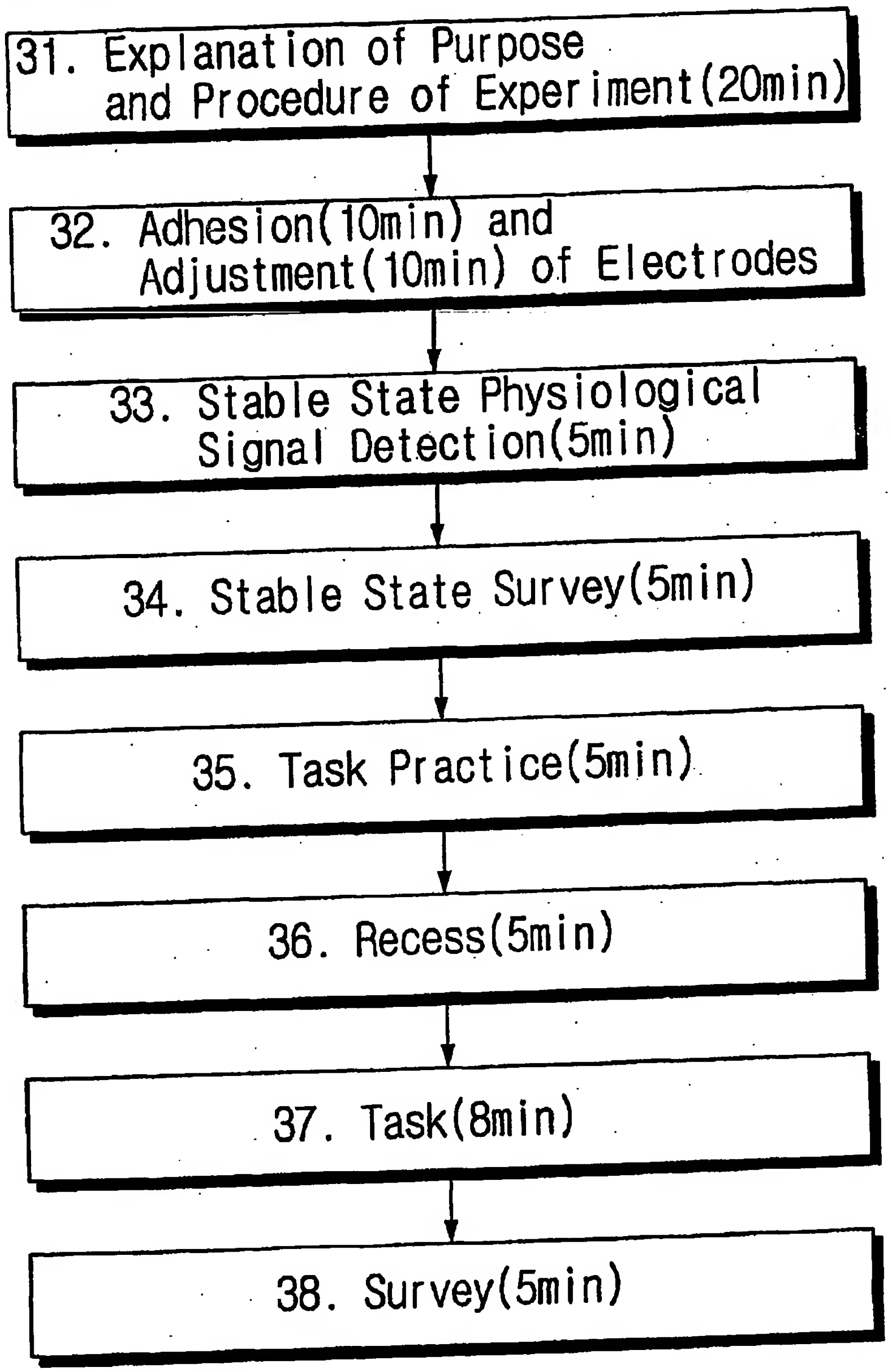

31. Explanation of Purpose and Procedure of Experiment(20min)
32. Adhesion(10min) and Adjustment(10min) of Electrodes
33. Stable State Physiological Signal Detection(5min)
34. Stable State Survey(5min)
35. Task Practice(5min)
36. Recess(5min)
37. Task(8min)
38. Survey(5min)

FIG. 21

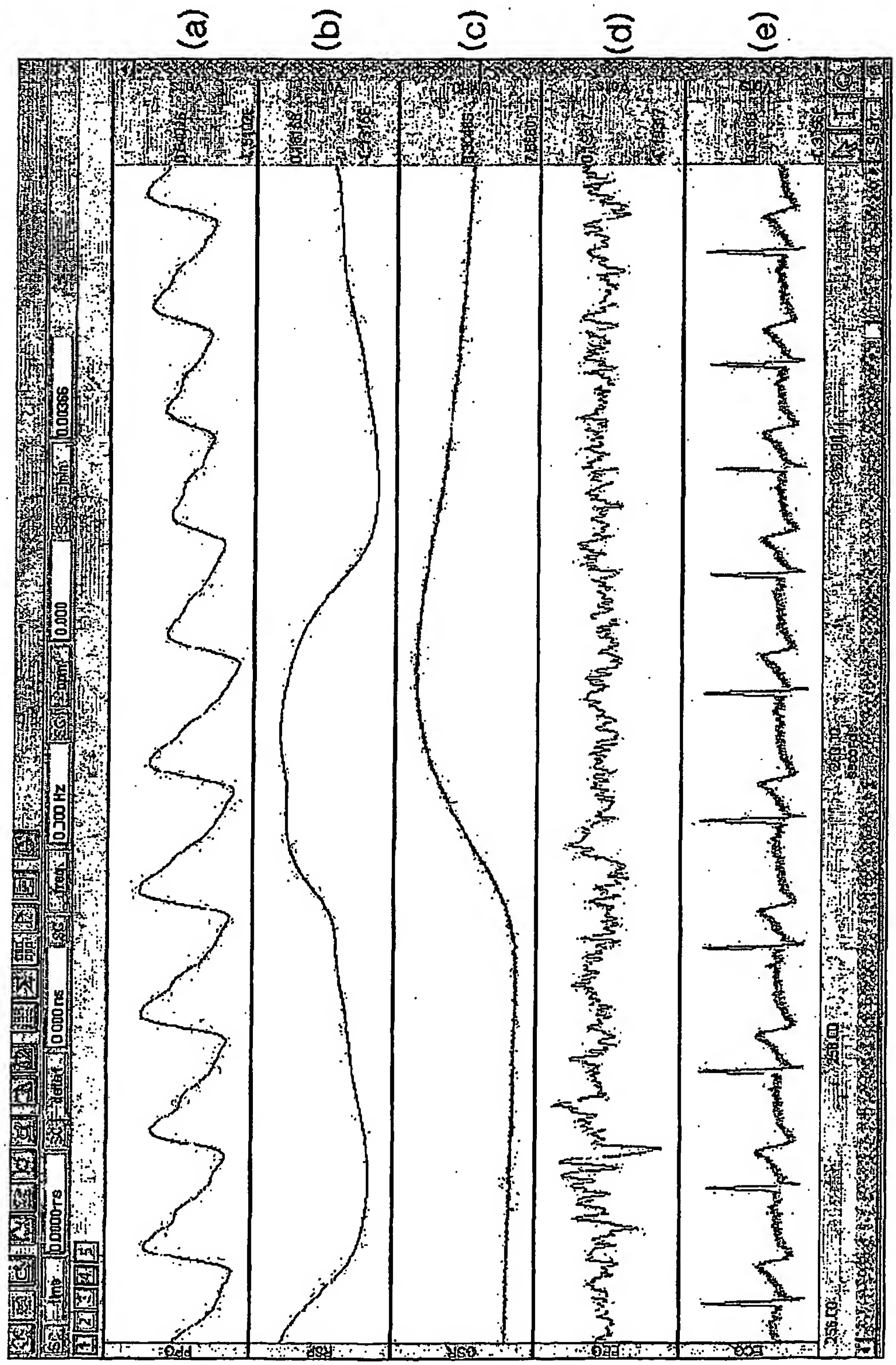


FIG. 22a

Mental Stress Subjective Evaluation Sheet

NO. ____

Name: Sex: Age: Date: / /

Please indicate on the blank
what you felt after conducting this experiment.

	0	1	2	3	4	5	6
feel nervous							
head feels light							
do not want to think							
feel irritated							
lose confidence							
lose persistence							
become angry							
lose strength							
feel bored							
feel tense							
get angry							
dissappointed at myself							
feel sad							
feel glad							

FIG. 22b

Body Stress Subjective Evaluation Sheet

NO. ____

Name: Sex: Age: Date: / /

Please indicate on the blank
what you felt after conducting this experiment.

	0	1	2	3	4	5	6
have headache							
shoulders are sore							
have backache							
mouth feels dry							
feel dizzy							
feel spasms on eyelids							
arms and legs ache							
feel sleepy							
face is turning red							
perspiring							
chest is throbbing							
eyes are tired							
have indigestion							

FIG. 23a

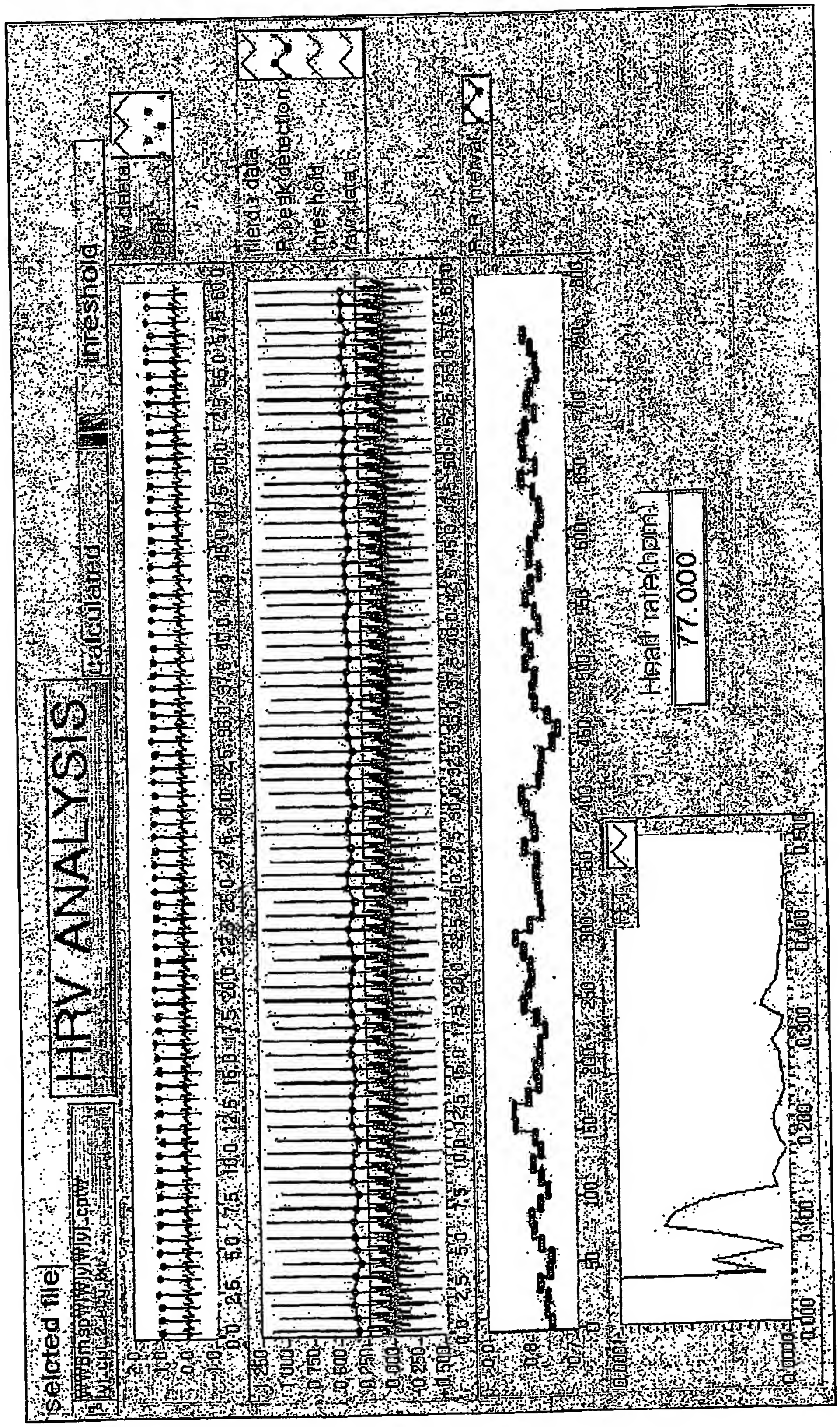

HRV ANALYSIS
selected file
calculated
threshold
filtered data
R-peak detection
threshold
R-R interval
Heart rate(bpm)
77.000

FIG. 23b

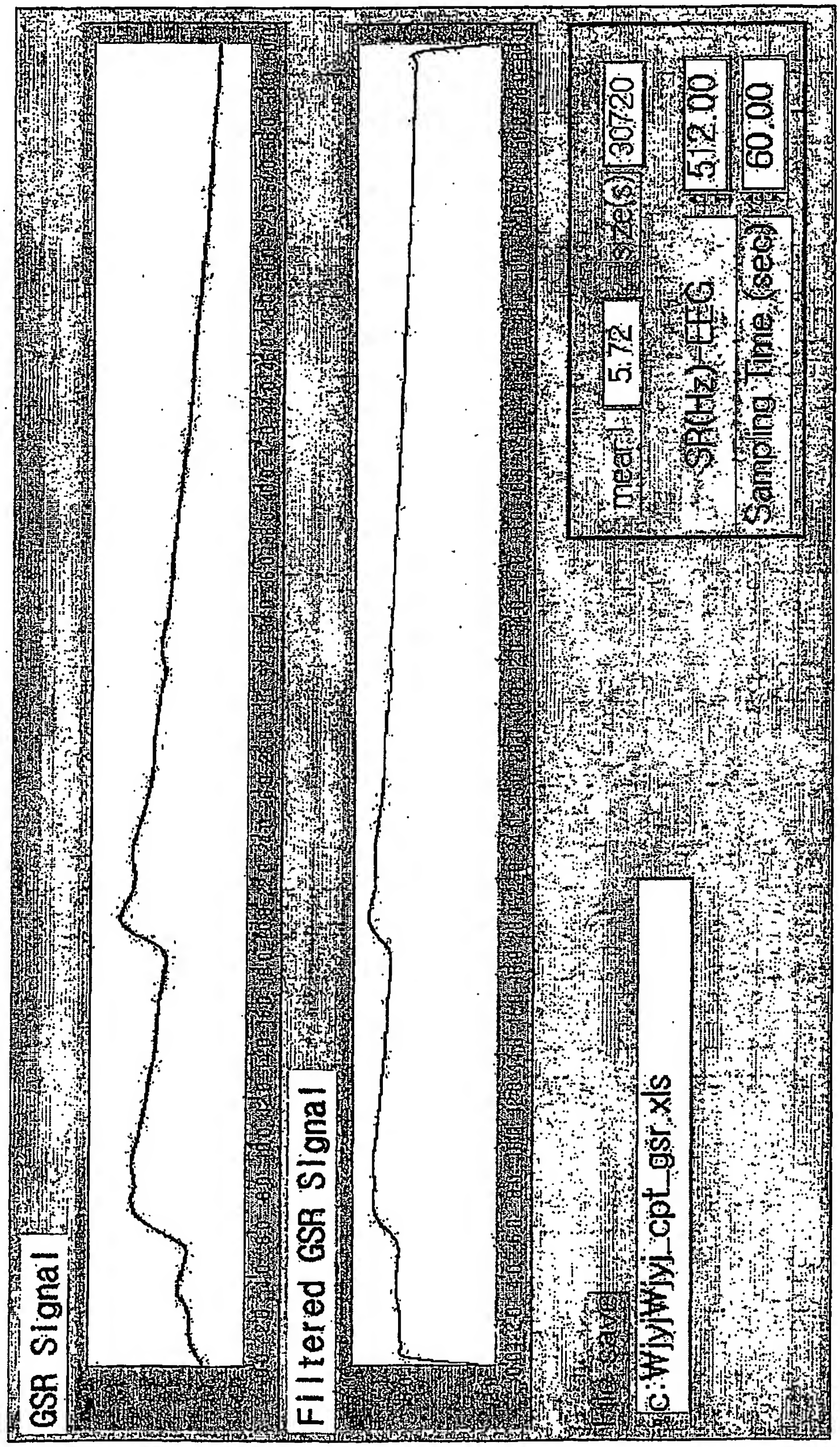
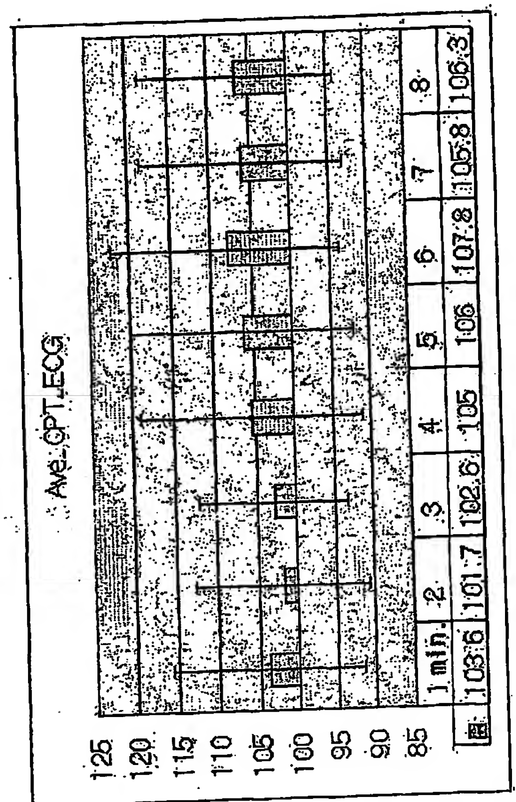
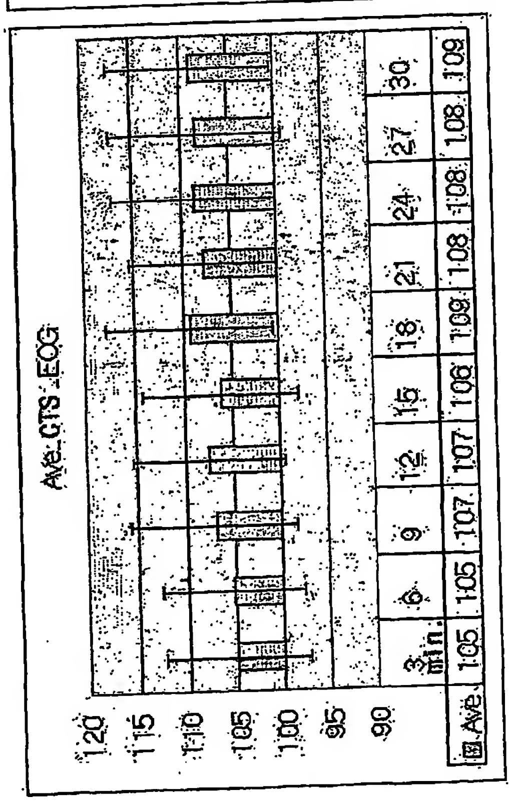

GSR Signal
Filtered GSR Signal
mean
5.72
size(s)
30720
SR(Hz) EEG
512.00
Sampling Time (sec)
60.00

FIG. 24a

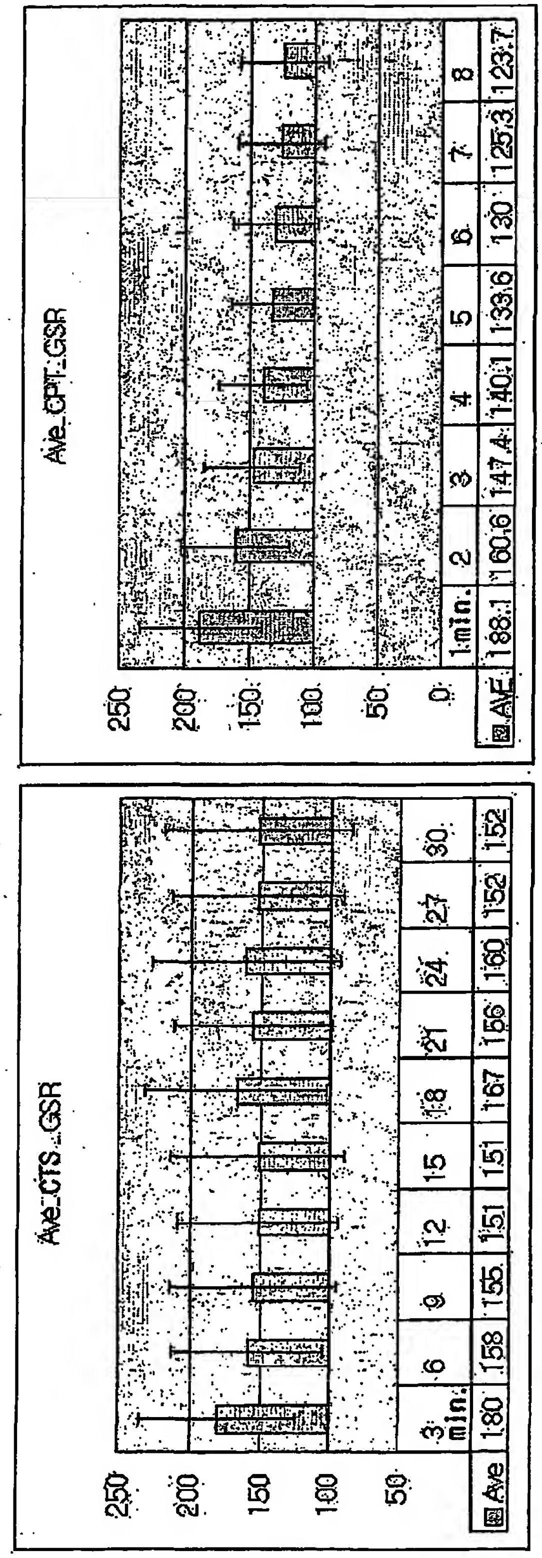


(b) CPT Test Stimulation



(a) Calculation Test Stimulation

FIG. 24b



(b) CPT Test Stimulation

(a) Calculation Test Stimulation

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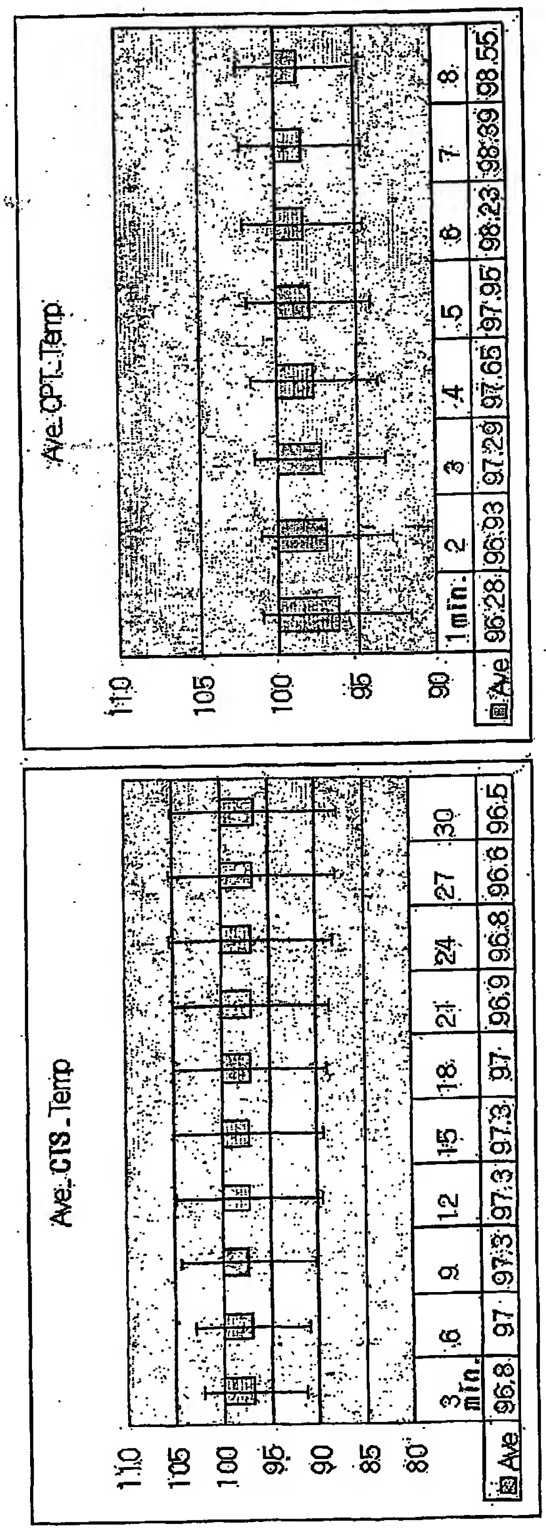
FIG. 24c



(b) CPT Test Stimulation

(a) Calculation Test Stimulation

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR00/01079

A. CLASSIFICATION F SUBJECT MATTER

IPC7 G06F 19/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimun documentation searched (classification system followed by classification symbols)

IPC7 G06F17/00, IPC7 G06F17/60, IPC7 G06F19/00

Documentation searched other than minimun documentation to the extent that such documents are included in the fileds searched

KOREAN PATENTS AND APPLICATIONS FOR INVENTIONS AINCE 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search trerms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US5921940 A (GEORGETOWN UNIV.) JULY. 13. 1999 ABSTRACT	1,2
A	US5568126 A (NONE) OCT. 22. 1996 ABSTRACT	1-9
A	US5282474 A (CENTRO DE NEURO CIENCIAS DE CUBA) FEB. 01. 1994 ABSTRACT	1-9
A	KR10-1999-6265 A (SETA) JAN. 25. 1999 ABSTRACT	1-9
A	KR10-1999-16853 A (SDI CO.) MARCH. 15. 1999 ABSTRACT	1-9
A	KR10-1999- 84052 A(KIN HYUN) DEC. 06. 1999 ABSTRACT	1-9

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

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"Y" document of particular relevence; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 JANUARY 2001 (26.01.2001)	29 JANUARY 2001 (29.01.2001)

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